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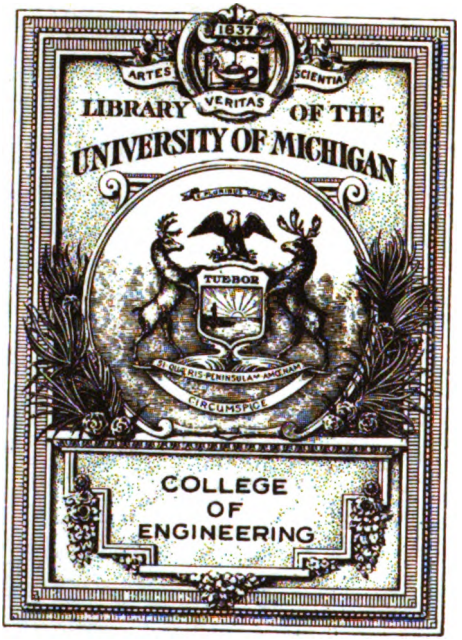
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HIGHWAYS GREEN BOOK

1920

FIRST ANNUAL EDITION

PUBLISHED BY
AMERICAN AUTOMOBILE ASSOCIATION
RIGGS BUILDING, WASHINGTON, D. C.

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Foreword

FIFTEEN years ago the total expenditure for roads and bridges in the United States annually amounted to less than $80,000,000. There is now available for highways construction and maintenance over a billion dollars, approximately one-half of which will be utilized during 1920.

During this 15-year period the mileage of surfaced roads has increased less than 5 per cent; that is, from about 7 to approximately 12 per cent. About nine-tenths of this mileage is composed of sand-clay, gravel, and water-bound macadam, none of which will withstand economically the strain of intense modern traffic requirements. Many of these so-called "improved roads" have been practically rebuilt from three to five or more times. Furthermore, a large percentage of these improvements has been on roads of secondary importance.

After an expenditure of more than $3,000,000,000 for construction, reconstruction, and maintenance during a decade and a half, we have only increased our mileage of durable types by about 12,500 miles, scarcely one-half of one per cent of the total mileage of the country.

It is obvious that something must be done to stop present wasteful and extravagant expenditure of vast sums of money on types of construction which are not adaptable to present-day needs, and that National, State, and local authorities should be compelled by the power of public opinion to devote more attention and funds to durable improvement of roads which accommodate great volumes of traffic.

America is entering upon an area of National progress in which the modern highway will be as important a factor as the railway has been since the invention of the locomotive.

When railways were constructed a proper road bed

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was first provided and then the rolling stock bought and put into commission.

Now under the extreme necessity of providing increased facilities of transportation, the process has been reversed in the matter of highways. The rolling stock has been bought and put into commission before providing proper road beds upon which to operate it.

The result is an economic drain so great that there is no community in the United States rich enough to endure it one hour longer than is absolutely necessary to remedy this condition.

It probably costs twice as much to operate motor or horse-drawn vehicles upon primitive road beds as upon modern highways. Deterioration, doubtless, is twice as great and the saving effected in the time and effort of those engaged in transportation is another economic item of equal value.

The next big job, now that the job overseas is completed, is to provide everywhere road beds as perfectly fitted to the economic operation of motor and horse-drawn vehicles as the road bed of the railway is fitted to the operation of railway rolling stock.

An encouraging sign of the times is the decided tendency to centralize the efforts of the Federal and State governments upon the roads of prime importance and to construct these roads with an eye to future traffic needs. To this end and as a timely contribution to the greatest road-building program ever undetraken by any nation the HIGHWAYS GREEN BOOK is dedicated.

A. A. A. GOOD ROADS BOARD.

M. O. ELDRIDGE, *Secretary.*

GEORGE C. DIEHL, *Chairman.*

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PART I

Information Relating to Road Improvements Under Federal, State and Local Control

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MILESTONES IN THE HISTORY OF AMERICAN HIGHWAYS

1632. First Road Legislation in North America enacted by the Virginia House of Burgesses. Following the English practice then prevailing, it provided that each person should work a certain number of days annually on the roads and that the parish surveyor should have charge of the administration of the law. All Colonial road legislation was modeled after this law.

1792. First Toll Road in the United States—The Lancaster Pike from Philadelphia to Lancaster, Pa. Many thousands of miles of turnpikes were constructed between 1792 and about 1830, this being distinctly the toll-road era. The coming of the railroad, however, the cost of toll collections and the irksome restrictions of the toll method upon travel caused the turnpike or toll-road era to gradually die out.

1806. Old National Road, authorized by Act of Congress, which was approved by President Jefferson, March 29, 1806. This, the first and greatest of the national roads, was at first authorized from a point on the Potomac river near Cumberland, Maryland, to a point on the Ohio river near Steubenville, Ohio, and later authorized to be extended to a point on the Mississippi at or near St. Louis. Appropriations aggregating $6,824,919.33 were made for this road.

1818. First Stage Coach bearing the United States mails from Cumberland to Wheeling passed over the Old National Road on August 1, 1818.

1821. First State Road Building Policy inaugurated by Kentucky. Between 1821 and 1837 there were 343 miles of State roads completed and 236 miles started. Work discontinued by financial panic of 1837.

1835. Last Direct Appropriation for construction of the National Road was made May 25, 1835.

1850. Local .Turnpike Companies had, by that year, absorbed practically all of the Old National Road.

1879. First Patent for Gasoline Motor filed by George B. Selden, which, after prolonged litigation, was pronounced by the courts to be the pioneer patent.

First Gasoline-Propelled Automobile built and operated in the United States by Charles E. Duryea.

1880. Formation of the League of American Wheelmen marking the definite influence of the bicycle as a factor in road improvement.

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1891. First State Aid Law passed by New Jersey Legislature, providing for the payment from the State treasury of one-third of the cost of State Aid roads.

1892. Formation of the National League for Good Roads, which entered vigorously into a campaign for the establishment of a Federal highways bureau.

1893. Establishment of the Office of Road Inquiry in the Department of Agriculture in accordance with Act of Congress approved March 3, 1893. Purpose of the office as defined in the statute was to make inquiries in regard to systems of road management throughout the United States; to make investigations in regard to the best methods of road making; to prepare publications on this subject, and to assist agricultural colleges and experiment stations in disseminating information on the subject. The appropriation was $10,000.

1895-1900. Introduction of the Automobile, the most powerful factor for good roads in the world's history.

1896. Only four gasoline automobiles in the United States: Duryea, Ford, and Haynes, American cars, and Benz, imported from Germany.

1902. Formation of the American Automobile Association, which marked the beginning of organized efforts by motor vehicle owners for many useful purposes and primarily for the improvement of the highways.

1904. Introduction of the Motor Truck which is revolutionizing short haul freight movement on the highways with almost the same quickness and thoroughness with which the passenger motor vehicle revolutionized passenger transport on the highways.

1905. State Bond Issue of $50,000,000 Authorized by New York for the construction of a definite highway system, thus marking the growth of the conception of highway classification and the growing distinction between main trunk lines and local market roads.

1908. First National Road Convention of American Automobile Association held at Buffalo, N. Y. This had been preceded in September, 1907, by the "Good Roads and Sane Use of Them" convention of the Automobile Club of Springfield, Mass.

1912. First Federal Aid Convention, Washington, January 16, 17, conducted by American Automobile Association, following which came the creation of the Joint Committee of the Senate and House of Representatives to investigate and report upon the subject of Federal Aid to Highways.

1912. Joint Committee of the Senate and House of Repre-

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sentatives on Federal Aid to Post Roads, established for the purpose of investigating the whole field of Government participation in road work and making recommendation to Congress for suitable legislation.

1912. Appropriation of $500,000 for Improvement of Selected Post Roads under the direction of the Secretary of Agriculture and the Postmaster General for the purpose of ascertaining the saving in rural delivery operation, etc., as a result of such improvement. States and other subdivisions were required to provide double the amount of the Federal appropriation to secure the benefits of the Act.

1913. Committee on Roads established as a standing committee in the U. S. House of Representatives.

1914. Formation of the American Association of State Highway Officials. This organization was formed at the American Road Congress held in Atlanta, Georgia, under the auspices of the American Automobile Association and the American Highway Association. These officials, in co-operation with the Federal Bureau of Public Roads, drafted a bill for Federal aid to roads. This measure was considered and endorsed by the A. A. A. at the annual meeting held in Boston, Mass., May, 1915, and with a few changes it was introduced in the Senate and House of Representatives by Senator Bankhead and Representative Shackleford respectively.

1916. Federal Aid Road Act passed by Congress, carrying an appropriation of $75,000,000 to aid the States in the construction of post roads during the five-year period and $10,000,000 for the construction of forest roads during the ten-year period. This measure greatly strengthened State highway departments as a basic requirement to participation by the States in the benefits of the Act was that there should be a State highway department and that the construction of highways under the terms of the act should be under the direct supervision of such department. The Act does not establish a highway system.

1919. Amendment to the Postoffice Appropriation Act carrying an appropriation of $209,000,000 as an addition to the appropriations carried by the Federal Aid Road Act, and liberalizing its provisions. Of this sum $9,000,000 was for Forest Reserve roads.

Townsend Bill Introduced February 13, by Senator Townsend of Michigan, providing for a National Highway System to be constructed and maintained under the supervision of a Federal Highway Commission. Revised Townsend bill introduced December 16, 1919. S-3572.

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HIGHWAY LEGISLATION IN THE UNITED STATES

The trend of road legislation during the past quarter of a century has been toward a more highly centralized control of road construction and maintenance. The State-aid idea, first developed in New Jersey in 1891, has spread rapidly throughout the country until today all of the States have highway departments, and most of them co-operate with their political subdivisions in planning, financing, constructing, and maintaining the more important local roads, while in a few of the States there have been adopted systems of State highways over which the State exercises complete control and pays the entire cost of construction and maintenance.

The extent of this movement may be shown by the fact that about 350,000 miles of road have been designated by the various States to receive State and Federal aid, that approximately 28 per cent of all the surfaced roads of the United States have been improved under some form of State-aid and about 25 per cent of all road funds are now contributed by the States.

The tendency toward centralized control of road affairs during the past few years would indicate that the State will ultimately take over, control, and finance the building of all important routes of State-wide importance and that the Federal Government will take over, construct, and maintain a small percentage of the roads in each State which are of nation-wide importance.

The tendency toward centralized control of road affairs may best be indicated by a brief outline of road legislation in the United States.

The first road legislation in North America began with the law enacted by the Virginia House of Burgesses in 1632, which followed the practice prevailing in England at that time. The parish was the unit of administration in England and each person was required to render a certain number of days service on the roads, while the parish surveyor was charged with the administration of the law. In this country the same general system was adopted, except that in New England the unit of administration was the town and in the southern colonies it was the county.

So long as the colonists clung to the seaboard and to the banks of navigable streams and maintained governments inde-

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pendent of each other this system of local control answered the needs of the time. The intercourse with a few small towns was maintained by boats, the rivers constituting the highways. Trade with the Indians was conducted by means of trails already existing. Thus, at the time of the Revolution, practically no improvement had been made in land transportation. Permanent bridges were unknown, and there were but few wheeled vehicles.

With the establishment of the Federal Government and the spread of population to the west and beyond the Alleghenies, new conditions arose which demanded more adequate inland transportation facilities. Between the settled portions of the seaboard and the newly established settlements in the west lay vast areas of wilderness. The Federal Government alone possessed sufficient power and financial resources to build the needed roads, and thus a strong sentiment arose in favor of National roads to be built and maintained by the National Government.

The advocates of this policy carried their point and in 1806 Congress passed a law providing for the building of a great National highway from Cumberland, Maryland, to the Ohio River. This road was later projected to St. Louis on the Mississippi River. Appropriations were made from time to time until in all about $7,000,000 had been provided. The road was laid out and graded as far west as Vandalia, Ill., and was macadamized to Indianapolis, Ind. Other appropriations were made from the Federal Treasury for National roads aggregating about $7,000,000, but the policy was abandoned about 1858 when the railroads had largely taken the place of highways for travel and mail transportation.

Contemporaneous with the period of National road building was the turnpike era. Thousands of miles of roads were built by turnpike companies whose capital was derived from subscriptions of States, counties, and individuals. The roads were maintained and the dividends were paid, when paid at all, by tolls collected from travelers. The toll roads were of great benefit to commerce and agriculture, and resulted in a considerable mileage of good roads which probably could not have been financed in any other way at that time. Most of them, however, yielded little revenue more than the expenditure for repairs and some of them not sufficient for that purpose. With the advent of railroads the building of turnpikes was gradually discontinued.

The policy of State participation in road building was inaugurated by Kentucky as early as 1821, and between that date

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and 1837 State appropriations amounting to over $2,500,000 were made for the construction of State roads. In 1837 a total of 343 miles of State roads had been completed and 236 miles were still under construction. Kentucky was the only State to inaugurate such a policy on an extensive scale before the Civil war, but the work in that State was finally abandoned as a result of the financial troubles which the country experienced about 1837.

From the close of the Civil war until 1890 may be referred to as the "dark ages" of road building in the United States. The National Government had discontinued appropriations for National roads. The turnpike companies had for the most part passed out of existence, and the roads had been to a large extent abandoned. The States gave no aid or encouragement to road building, and in many cases had provided specifically by constitutional amendment against aiding in any work or internal improvements. The administration of roads reverted to the local systems prevailing during the earlier colonial period, in which the town and township of the north and the county of the south and west formed the administrative unit and local revenues in the form of statute labor, and in some cases a property tax, which could be worked out, were largely depended upon for the construction and maintenance of roads. This system of local control was fundamentally weak in that it failed to insure skilled supervision or labor, or to provide adequate revenues. As a result the roads throughout the United States during this period were in a deplorable condition.

The decade beginning in 1890 marked the dawn of a new era in road building in this country. The sentiment which had been steadily growing for a more centralized control of road affairs, more adequate funds and for skilled supervision found expression in the State-aid law passed by the legislature of New Jersey in 1891. That was the first State to adopt the plan of apportioning the cost between the State and local subdivisions according to certain requirements.

After New Jersey had established the principle of State-aid and State supervision and proved that it offered a practical solution of the problem other States began to adopt similar legislation. Constitutional barriers have been gradually removed and in 1917, just 27 years after the New Jersey law was adopted, all of the 48 States had created State highway departments and were extending aid in one form or another.

The first State laws in many of the States provided only for investigation and for the collection and dissemination of useful

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information on road building, or for State supervision on request of local officials; such legislation usually being preliminary to State participations in road building. Practically all of the laws as originally passed, recognizing the idea of local self-government, provided for a considerable amount of cooperation on the part of local officials, even where State funds were involved. In most States the local officials were given a voice in designating the roads to which joint funds were to be applied, and in designing and planning the work, while in some States provision was made that the contracts be let and the work be carried on by local officials under State supervision or inspection.

In most States, however, where the best results have been obtained, the work involving State funds has nearly always been guided in all essential details by State highway officials. The result has been that, after a few years experience, communities have learned that the State road commissions or departments were so much better equipped to handle the work the people have in most cases been not only willing, but glad to relinquish to the State all control over State or State-aid roads. This sentiment has led in several States, notably in California, Delaware, Connecticut, Maine, Maryland, Massachusetts, New York, New Jersey, Pennsylvania, Rhode Island and Virginia, to the establishment of road systems built and maintained entirely by and at the expense of the State.

State-aid and State supervision have tended to discourage the election and the promiscuous selection of untrained men to take charge of local road affairs. It has taught the people that road building is an art based on science, and that, to obtain the best results, all road taxes should be paid in cash and expended under the direction of trained and experienced road builders. Most of the States have, therefore, during the past 25 years adopted the cash system of taxation, and have provided for the selection of competent highway engineers to direct the expenditure of road funds.

Coextensive with the idea of State aid and supervision has grown up a sentiment in favor of Federal aid and supervision and for a Federal system of highways constructed and maintained wholly at the expense of the Federal Government. This sentiment found expression in Congress in 1893 when $10,000 was appropriated for the purpose of investigating road conditions in the United States and for collecting and disseminating useful information on road building. This marked the beginning of the work of the present Bureau of Public Roads. Since that time the field of such work has

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been broadened and extended, and the appropriation for educational and research work, exclusive of Federal aid for post roads, now amounts to $500,000 annually.

In 1912 an appropriation of $500,000 was made by Congress for the purpose of aiding in the building of experimental post roads. The Government paid one-third of the cost of these roads and the work of construction was supervised by the Office of Public Roads. The idea of Federal participation was still further extended in 1916 when Congress appropriated $75,000,000 with which to pay during the succeeding 5 years up to one-half of the cost of construction of post roads, and $10,000,000 to aid in building roads within or partly within the National forests during the ensuing 10 years. Additional appropriations have since been made of $200,000,000 for Federal aid and $9,000,000 for forest roads for expenditure during the fiscal years 1919 to 1921.

From the above it will be seen that the situation is constantly changing and that the management of roads in the United States has not yet crystallized into hard and fast systems which might be expected to remain constant through a long period of time. The trend has been along the lines of more compact and effective organization, and business-like methods, and it is possible that with the influence of both the State and Federal authority the administration of our public roads will be placed upon a firm and satisfactory basis within the next few years.



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FEDERAL AID ROAD ACT OF 1916

PUBLIC LAW—No. 156—64TH CONGRESS

AN ACT To provide that the United States shall aid the States in the construction of rural post roads, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of Agriculture is authorized to cooperate with the States, through their respective State highway departments, in the construction of rural post roads; but no money apportioned under this Act to any State shall be expended therein until its legislature shall have assented to the provisions of this Act, except that, until the final adjournment of the first regular session of the legislature held after the passage of this Act, the assent of the governor of the State shall be sufficient. The Secretary of Agriculture and the State highway department of each State shall agree upon the roads to be constructed therein and the character and method of construction: Provided, That all roads constructed under the provisions of this Act shall be free from tolls of all kinds.

SEC. 2. That for the purpose of this Act the term "rural post road"[1] shall be construed to mean any public road over which the United States mails now are or may hereafter be transported, excluding every street and road in a place having a population, as shown by the latest available federal census, of two thousand five hundred or more, except that portion of any such street or road along which the houses average more than two hundred feet apart; the term "State highway department" shall be construed to include any department of another name, or commission, or official or officials, of a State empowered, under its laws, to exercise the functions ordinarily exercised by a State highway department; the term "construction" shall be construed to include reconstruction and improvement of roads; "properly maintained" as used herein shall be construed to mean the making of needed repairs and the preservation of a reasonably smooth surface considering the type of the road; but shall not be held to include extraordinary repairs, nor reconstruction; necessary bridges and culverts shall be deemed parts of the respective roads covered by the provisions of this Act.

SEC. 3. That for the purpose of carrying out the provisions of this Act there is hereby appropriated, out of any money in the Treasury not otherwise appropriated, for the fiscal year ending

[1] Amended by Section 5 of the Act approved February 28, 1919.

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June thirtieth, nineteen hundred and seventeen, the sum of $5,000,000; for the fiscal year ending June thirtieth, nineteen hundred and eighteen, the sum of $10,000,000; for the fiscal year ending June thirtieth, nineteen hundred and nineteen, the sum of $15,000,000; for the fiscal year ending June thirtieth, nineteen hundred and twenty, the sum of $20,000,000; and for the fiscal year ending June thirtieth, nineteen hundred and twenty-one, the sum of $25,000,000. So much of the appropriation apportioned to any State for any fiscal year as remains unexpended at the close thereof shall be available for expenditure in that State until the close of the succeeding fiscal year, except that amounts apportioned for any fiscal year to any State which has not a State highway department shall be available for expenditure in that State until the close of the third fiscal year succeeding the close of the fiscal year for which such apportionment was made. Any amount apportioned under the provisions of this Act unexpended at the end of the period during which it is available for expenditure under the terms of this section shall be reapportioned, within sixty days thereafter, to all the States in the same manner and on the same basis, and certified to the Secretary of the Treasury and to the State highway departments and to the governors of States having no State highway departments in the same way as if it were being apportioned under this Act for the first time: *Provided,* That in States where the constitution prohibits the State from engaging in any work of internal improvements, then the amount of the appropriation under this Act apportioned to any such State shall be turned over to the highway department of the State or to the governor of said State to be expended under the provisions of this Act and under the rules and regulations of the Department of Agriculture, when any number of counties in any such State shall appropriate or provide the proportion or share needed to be raised in order to entitle such State to its part of the appropriation apportioned under this Act.

SEC. 4. That so much, not to exceed three per centum, of the appropriation for any fiscal year made by or under this Act as the Secretary of Agriculture may estimate to be necessary for administering the provisions of this Act shall be deducted for that purpose, available until expended. Within sixty days after the close of each fiscal year the Secretary of Agriculture shall determine what part, if any, of the sums theretofore deducted for administering the provisions of this Act will not be needed for that purpose and apportion such part, if any, for the fiscal year then current in the same manner and on the same basis, and certify it to the Secretary of the Treasury and to the State

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highway departments, and to the governors of States having no State highway departments, in the same way as other amounts authorized by this Act, to be apportioned among all the States for such current fiscal year. The Secretary of Agriculture, after making the deduction authorized by this section, shall apportion the remainder of the appropriation for each fiscal year among the several States in the following manner: One-third in the ratio which the area of each State bears to the total area of all the States; one-third in the ratio which the population of each State bears to the total population of all the States, as shown by the latest available Federal census; one-third in the ratio which the mileage of rural delivery routes and star routes in each State bears to the total mileage of rural delivery routes and star routes in all the States, at the close of the next preceding fiscal year, as shown by the certificate of the Postmaster General, which he is directed to make and furnish annually to the Secretary of Agriculture.

SEC. 5. That within sixty days after the approval of this Act the Secretary of Agriculture shall certify to the Secretary of the Treasury and to each State highway department and to the governor of each State having no State highway department the sum which he has estimated to be deducted for administering the provisions of this Act and the sum which he has apportioned to each State for the fiscal year ending June thirtieth, nineteen hundred and seventeen, and on or before January twentieth next preceding the commencement of each succeeding fiscal year shall make like certificates for such fiscal year.

SEC. 6. That any State desiring to avail itself of the benefits of this Act shall, by its State highway department, submit to the Secretary of Agriculture project statements setting forth proposed construction of any rural post road or roads therein. If the Secretary of Agriculture approve a project, the State highway department shall furnish to him such surveys, plans, specifications, and estimates therefor as he may require: *Provided, however,* That the Secretary of Agriculture shall approve only such projects as may be substantial in character and the expenditure of funds hereby authorized shall be applied only to such improvements. Items included for engineering, inspection, and unforeseen contingencies shall not exceed ten per centum of the total estimated cost of the work. If the Secretary of Agriculture approve the plans, specifications, and estimates, he shall notify the State highway department and immediately certify the fact to the Secretary of the Treasury. The Secretary of the Treasury shall thereupon set aside the share of the United States payable under this Act

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on account of such project, which shall not exceed fifty per centum of the total estimated cost thereof. No payment of any money apportioned under this Act shall be made on any project until such statement of the project, and the plans, specifications, and estimates therefor, shall have been submitted to and approved by the Secretary of Agriculture.

When the Secretary of Agriculture shall find that any project so approved by him has been constructed in compliance with said plans and specifications he shall cause to be paid to the proper authority of said State the amount set aside for said project: *Provided,* That the Secretary of Agriculture may, in his discretion, from time to time make payments on said construction as the same progresses, but these payments including previous payments, if any, shall not be more than the United States' pro rata part of the value of the labor and materials which have been actually put into said construction in conformity to said plans and specifications; nor shall any such payment be in excess of $10,000[1] per mile, exclusive of the cost of bridges of more than twenty feet clear span. The construction work and labor in each State shall be done in accordance with its laws, and under the direct supervision of the State highway department, subject to the inspection and approval of the Secretary of Agriculture and in accordance with the rules and regulations made pursuant to this Act.

The Secretary of Agriculture and the State highway department of each State may jointly determine at what times, and in what amounts, payments, as work progresses, shall be made under this Act. Such payments shall be made by the Secretary of the Treasury, on warrants drawn by the Secretary of Agriculture, to such official, or officials, or depository, as may be designated by the State highway department and authorized under the laws of the State to receive public funds of the State or county.

SEC. 7. To maintain the roads constructed under the provisions of this Act shall be the duty of the States, or their civil subdivisions, according to the laws of the several States. If at any time the Secretary of the Agriculture shall find that any road in any State constructed under the provisions of this Act is not being properly maintained he shall give notice of such fact to the highway department of such State and if within four months from the receipt of said notice said road has not been put in a proper condition of maintenance then the Secretary of Agriculture shall thereafter refuse to approve any project for road con-

[1] Amended by Section 5 of the Act approved February 28, 1919.

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struction in said State, or the civil subdivision thereof, as the fact may be, whose duty it is to maintain said road, until it has been put in a condition of proper maintenance.

SEC. 8. That there is hereby appropriated and made available until expended, out of any moneys in the National Treasury not otherwise appropriated, the sum of $1,000,000 for the fiscal year ending June thirtieth, nineteen hundred and seventeen, and each fiscal year thereafter, up to and including the fiscal year ending June thirtieth, nineteen hundred and twenty-six, in all $10,000,000, to be available until expended under the supervision of the Secretary of Agriculture, upon request from the proper officers of the State, Territory, or county for the survey, construction, and maintenance of roads and trails within or only partly within the national forests, when necessary for the use and development of resources upon which communities within and adjacent to the national forests are dependent: *Provided,* That the State, Territory, or county shall enter into a cooperative agreement with the Secretary of Agriculture for the survey, construction, and maintenance of such roads or trails upon a basis equitable to both the State, Territory, or county, and the United States: *And provided also,* That the aggregate expenditures in any State, Territory, or county shall not exceed ten per centum of the value, as determined by the Secretary of Agriculture, of the timber and forage resources which are or will be available for income upon the national forest lands within the respective county or counties wherein the roads or trails will be constructed; and the Secretary of Agriculture shall make annual report to Congress of the amounts expended hereunder.

That immediately upon the execution of any cooperative agreement hereunder the Secretary of Agriculture shall notify the Secretary of the Treasury of the amount to be expended by the United States within or adjacent to any national forest thereunder, and beginning with the next fiscal year and each fiscal year thereafter the Secretary of the Treasury shall apply from any and all revenues from such forest ten per centum thereof to reimburse the United States for expenditures made under such agreement until the whole amount advanced under such agreement shall have been returned from the receipts from such national forest.

SEC. 9. That out of the appropriations made by or under this Act, the Secretary of Agriculture is authorized to employ such assistants, clerks, and other persons in the city of Washington and elsewhere, to be taken from the eligible lists of the Civil Service Commission, to rent buildings, outside of the city of Washington,

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to purchase such supplies, material, equipment, office fixtures. and apparatus, and to incur such travel and other expense as he may deem necessary for carrying out the purposes of this Act.

SEC. 10. That the Secretary of Agriculture is authorized to make rules and regulations for carrying out the provisions of this Act.

SEC. 11. That this Act shall be in force from the date of its passage.

Approved, July 11, 1916.

AMENDMENTS TO THE FEDERAL AID ROAD ACT OF 1919

[H. R. 13308—65TH CONGRESS.]

AN ACT making appropriations for the service of the Postoffice Department for the fiscal year ending June 30, 1920, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

* * * * * *

SEC. 5. That the Act entitled "An Act to provide that the United States shall aid the States in the construction of rural post roads, and for other purposes," approved July 11, 1916, is hereby amended to provide that the term "rural post roads," as used in Section 2 of said Act, shall be construed to mean any public road a major portion of which is now used, or can be used, or forms a connecting link not to exceed ten miles in length of any road or roads now or hereafter used for the transportation of the United States mails, excluding every street and road in a place having a population, as shown by the latest available Federal census, of two thousand five hundred or more, except that portion of any such street or road along which the houses average more than two hundred feet apart: *Provided,* That Section 6 of said Act be further amended so that the limitation of payments not to exceed $10,000 per mile, exclusive of the cost of bridges of more than twenty feet clear span, which the Secretary of Agriculture may make, be, and the same is, increased to $20,000 per mile.

SEC. 6. That for the purpose of carrying out the provisions of said Act, as herein amended, there is hereby appropriated, out of any money in the Treasury not otherwise appropriated, the following additional sums: The sum of $50,000,000 for the fiscal year ending June 30, 1919, and available immediately; the sum of $75,000,000 for the fiscal year ending June 30, 1920; and the sum of $75,000,000 for the fiscal year ending June 30, 1921; said additional sums to be expended in accordance with the provisions of

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said Act: *Provided,* That where the constitution of any State prohibits the same from engaging upon internal improvements or from contracting public debts for extraordinary purposes in an amount sufficient to meet the monetary requirements of the Act of July 11, 1916, or any Act amendatory thereof, or restricts annual tax levies for the purpose of constructing and improving roads and bridges, and where a constitutional alteration or amendment to overcome either or all of such prohibitions must be submitted to a referendum at a general election, the sum to which such State is entitled under the method of apportionment provided in the Act of July 11, 1916, or any Act amendatory thereof, shall be withdrawn by the Secretary of the Treasury from the principal fund appropriated by the Act of July 11, 1916, or any Act amendatory thereof, upon receipt of the certification of the governor of such State to the existence of either or all of said prohibitions, and such sum shall be carried by the Secretary of the Treasury as a separate fund for future disbursement as hereinafter provided: *Provided further,* That when, by referendum, the constitutional alterations or amendments necessary to the enjoyment of the sum so withdrawn have been approved and ratified by any State, the Secretary of the Treasury, upon receipt of certification from the governor of such State to such effect, shall immediately make available to such State, for the purposes set forth in the Act of July 11, 1916, or any Act amendatory thereof, the sum withdrawn as hereinbefore provided: *Provided further,* That nothing herein shall be deemed to prevent any State from receiving such portion of said principal sum as is available under its existing constitution and laws: *Provided further,* That in the expenditure of this fund for labor preference shall be given, other conditions being equal, to honorably discharged soldiers, sailors, and marines, but any other preference or discrimination among citizens of the United States in connection with the expenditure of this appropriation is hereby declared to be unlawful.

SEC. 7. That the Secretary of War be, and he is hereby, authorized in his discretion to transfer to the Secretary of Agriculture all available war material, equipment, and supplies not needed for the purposes of the War Department, but suitable for use in the improvement of highways, and that the same be distributed among the highway departments of the several States to be used on roads constructed in whole or in part by Federal aid, such distribution to be made upon a value basis of distribution the same as provided by the Federal Aid Road Act, approved July 11, 1916: *Provided,* That the Secretary of Agriculture, at his discretion, may reserve from such distribution not to exceed 10 per centum

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of such material, equipment, and supplies for the use in the construction of national forest roads or other roads constructed under his direct supervision.

SEC. 8. That there is hereby appropriated, out of any money in the Treasury not otherwise appropriated, for the fiscal year ending June 30, 1919, the sum of $3,000,000, for the fiscal year ending June 30, 1920, the sum of $3,000,000, and for the fiscal year ending June 30, 1921, the sum of $3,000,000, available until expended by the Secretary of Agriculture in cooperation with the proper officials of the State, Territory, insular possession, or county, in the survey, construction, and maintenance of roads and trails within or partly within the national forests, when necessary for the use and development of resources of the same or desirable for the proper administration, protection, and improvement of any such forest. Out of the sums so appropriated the Secretary of Agriculture may, without the cooperation of such officials, survey, construct, and maintain any road or trail within a national forest which he finds necessary for the proper administration, protection, and improvement of such forest, or which in his opinion is of national importance. In the expenditure of this fund for labor preference shall be given, other conditions being equal, to honorably discharged soldiers, sailors, and marines.

The Secretary of Agriculture shall make annual report to Congress of the amount expended hereunder.

SEC. 9. That no officer or enlisted man of the Army, Navy, or Marine Corps shall be detailed for work on the roads which come within the provisions of this Act except by his own consent: *And provided further,* That the Secretary of Agriculture, through the War Department, shall ascertain the number of days any such soldiers, sailors, and marines have worked on the public roads in the several States (other than roads within the limits of cantonments or military reservations in the several States) during the existing war and also the location where they worked and their names and rank, and report to Congress at the beginning of its next regular session: *Provided further,* That when any officer or enlisted man in the Army, the Navy, or the Marine Corps shall have been or may be in the future detailed for labor in the building of roads or other highway construction or repair work (other than roads within the limits of cantonments or military reservations in the several States) during the existing war, the pay of such officer or enlisted man shall be equalized to conform to the compensation paid to civilian employees in the same or like employment and the amount found to be due such officers, soldiers, sailors, and marines, less the amount of his pay as such officer, soldier, sailor, or marine, shall be paid to him from the 1920

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appropriation herein allotted to the States wherein such highway construction or repair work was or will be performed.

Approved, February 28, 1919.

* * * * * *

The rules and regulations of the Secretary of Agriculture for carrying out the Federal Aid Road Act issued September 1, 1916, revised April 28, 1917, and March 12, 1919, may be obtained by addressing the Chief of the Bureau of Public Roads, Willard Building, Washington, D. C.

Federal aid apportionments for 1921 *and total apportionment* 1917-1921

STATE	Apportionment of 1921		Total Federal Aid 1917-1921
	Under Act 1916	Under P. O. Act 1919	
Alabama	$ 526,220.88	$1,578,662.63	$5,776,552.58
Arizona	343,411.04	1,030,233.12	3,771,351.69
Arkansas	421,294.52	1,263,883.57	4,619,929.47
California	763,668.88	2,291,006.63	8,384,354.57
Colorado	438,939.79	1,316,819.38	4,780,064.14
Connecticut	153,337.36	460,012.07	1,689,324.70
Delaware	40,668.70	122,006.11	447,654.83
Florida	286,861.98	860,585.94	3,150,112.48
Georgia	674,287.74	2,022,863.22	7,407,578.62
Idaho	306,512.48	919,537.45	3,360,388.86
Illinois	1,091,266.98	3,273,800.93	12,024,266.97
Indiana	671,763.32	2,015,289.95	7,415,292.61
Iowa	720,332.18	2,160,996.56	7,939,343.14
Kansas	717,811.16	2,153,433.46	7,895,309.07
Kentucky	487,938.86	1,463,816.57	5,370,064.79
Louisiana	340,557.78	1,021,673.35	3,742,524.57
Maine	240,057.54	720,172.62	2,645,963.57
Maryland	216,749.65	650,248.96	2,390,749.07
Massachusetts	368,197.21	1,104,591.62	4,052,565.09
Michigan	722,916.99	2,168,750.98	7,961,295.55
Minnesota	710,522.33	2,131,567.00	7,815,383.02
Mississippi	451,889.29	1,355,667.88	4,951,542.29
Missouri	846,974.90	2,540,924.70	9,322,075.71
Montana	501,747.53	1,505,242.60	5,498,827.31
Nebraska	533,435.50	1,600,306.48	5,866,761.66
Nevada	319,086.11	957,258.32	3,527,276.18
New Hampshire	103,709.73	311,129.20	1,143,088.99
New Jersey	296,889.11	890,667.34	3,265,299.02
New Mexico	399,616.96	1,198,850.89	4,389,794.61
New York	1,242,973.28	3,728,919.83	13,688,801.67
North Carolina	569,763.45	1,709,290.35	6,270,690.68
North Dakota	384,056.95	1,152,170.85	4,222,487.70
Ohio	926,561.70	2,779,685.11	10,202,947.71
Oklahoma	575,619.58	1,726,858.75	6,338,245.60
Oregon	394,038.01	1,182,114.02	4,332,178.26
Pennsylvania	1,147,986.51	3,443,959.54	12,632,644.29
Rhode Island	58,314.22	174,942.65	641,166.13
South Carolina	359,004.76	1,077,014.28	3,946,617.50
South Dakota	403,944.86	1,211,834.58	4,452,883.04
Tennessee	565,478.48	1,696,435.42	6,228,137.98
Texas	1,465,399.62	4,396,198.84	16,100,404.77
Utah	282,393.91	847,181.75	3,117,206.38
Vermont	112,519.27	337,557.82	1,242,103.73
Virginia	494,418.46	1,483,255.37	5,451,730.28
Washington	361,156.95	1,083,470.84	3,971,675.83
West Virginia	265,038.19	795,114.58	2,922,504.45
Wisconsin	636,236.34	1,908,709.01	7,004,280.67
Wyoming	308,428.96	925,286.88	3,378,558.17
Totals	$24,250,000.00	$72,750,000.00	$266,750,000.00

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STATUS OF FEDERAL AID ROAD WORK[1]

Of the post road appropriations made by the Congress there was available during the fiscal year a total of $80,000,000, the sum of the appropriations for the fiscal years 1917, 1918, and 1919. From this there was deducted the 3 per cent allowed by law for the administrative purposes and the remainder, or $77,600,000, was apportioned among the several States. Of this sum there was paid to the States during the fiscal year for road construction work a total of $2,702,247. At the close of the fiscal year 1918 there had been paid to the States $425,445. So that the grand total of all payments to the States on June 30, 1919, was $3,127,693, which left to the credit of the States an unexpended balance of $74,472,306. In addition, the $95,000,000 appropriated for the fiscal year 1920 was apportioned to the States, after deducting the 3 per cent for administrative purposes, and that sum became available with the close of the fiscal year. On July 1, 1919, therefore, there was available to the credit of the States for expenditure a total of $166,622,306.

During the fiscal year the United States Department of Agriculture approved project statements submitted by the States for 736 road projects, involving the improvement of 6,470 miles of road at an estimated cost of $91,495,797, and on which $38,664,397 Federal aid was requested. Up to June 30, 1918, 580 project statements had been approved for 6,249.40 miles of road, estimated to cost $42,278,770, and on which was requested $16,049,821 Federal aid. So that on June 30, 1919, there had been approved project statements for a total of 1,316 projects, involving 12,719.98 miles of road estimated to cost $133,774,568, of which $54,714,219 in Federal aid was requested. At the close of the fiscal year, therefore, there remained to the credit of the States an unallotted balance, including the additional funds which then became available, of $111,908,087.

Agreements with State highway departments were executed during the fiscal year to cover 453 of the projects for which project statements had been approved. The estimated cost of the projects covered by these agreements amounted to $41,598,209, of which amount there was set aside in the Treasury $18,031,680 as Federal aid. At the close of the fiscal year 1918 there had been executed a total of 224 such agreements of an approved estimate of cost of $14,820,633, of which there was set aside in the Treasury $5,899,936. Thus, at the close of the fiscal year

[1] Extract from the report of the Chief of the Bureau of Public Roads of the United States Department of Agriculture for the fiscal year ending June 30, 1919.

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1919 a total of 677 agreements to cover projects had been executed, involving a total approved estimate of cost of $56,418,843, and a total of $23,931,617 Federal aid. The projects for which agreements had been executed at the close of the fiscal year call for the improvement of a total of 5,791.23 miles of road.

Under the terms of the Federal Aid Road Act the apportionments to the States for each fiscal year remain available for expenditure until the close of the succeeding fiscal year, but it is construed that funds covered by agreements are expended within the meaning of the law. Each State had a sufficient amount of funds under agreement at the close of the fiscal year to prevent its losing any part of the funds apportioned to it.

Statistical information is shown in the following tables as to the status of Federal aid projects, the miles and types of roads included in Federal aid projects, and the expenditure and construction of roads during the fiscal year:

Summary of miles and types of roads included in Federal aid projects executed during fiscal years 1917, 1918, *and* 1919.

TYPE	Mileage Approved	Per Cent of Total	Total Cost
Earth	1,622.520	28.02	$6,645,244.86
Sand-clay	626.705	10.83	2,657,970.03
Gravel	1,601,744	27.67	10,238,677.92
Macadam	163.512	2.82	1,823,550.67
Macadam mat top	170.078	2.94	1,275,712.95
Bituminous macadam	126.204	2.18	3,106,967.48
Bituminous concrete	118.170	2.04	2,821,214.59
Concrete	590.325	10.20	18,172,084.19
Brick	66.828	1.15	2,845,429.91
Miscellaneous	37.791	.65	189,614.53
Undetermined	665.992	11.50	6,925,839.97

DISTRIBUTION OF SURPLUS WAR EQUIPMENT, SUPPLIES, AND MATERIALS

As a further stimulus to road-building activities and to facilitate the resumption of such work by the several State highway departments, Congress also incorporated in the Postoffice Appropriation Act of February 28, 1919, a provision authorizing the Secretary of War to turn over to the Secretary of Agriculture for distribution to the States available war material, equipment, and supplies suitable for use in the improvement of highways and not needed for the purposes of the War Department, to be used on roads constructed in whole or in part by Federal aid, the Secretary of Agriculture being authorized to retain from such distribution not to exceed 10 per cent of such material, equipment, and supplies for use in the construction of national forest roads or other roads constructed under his direct supervision. Such materials were

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Projects Statement Approved by States

STATE	Number of Projects			Total Estimated Cost			Federal Aid Requested			Mileage Covered		
	Prior to June 30, 1918	Fiscal Year 1919	Total to Date	To June 30, 1918	Fiscal Year 1919	To June 30, 1919	To June 30, 1918	Fiscal Year 1919	To June 30, 1919	To June 30, 1918	Fiscal Year 1919	To June 30, 1919
Alabama	26	25	51	$ 596,583.67	$1,243,338.37	$ 1,839,922.04	$ 295,976.59	$ 616,371.86	$ 912,348.45	174.295	137.222	311.517
Arizona	3	5	8	252,523.63	639,948.81	892,472.44	126,249.89	315,622.82	441,872.71	55.560	37.831	93.391
Arkansas	18	4	22	541,410.19	278,005.34	819,415.53	217,976.98	96,093.56	314,070.54	86.403	36.952	123.355
California	6	10	16	1,163,322.27	2,380,168.79	3,543,491.06	545,156.13	1,190,084.38	1,735,240.51	89.790	110.290	200.080
Colorado	8	5	13	559,268.70	193,489.31	752,758.01	279,634.34	96,744.66	376,379.00	160.510	48.435	208.945
Connecticut	1	3	4	148,694.04	1,486,145.51	1,634,839.55	53,000.00	737,230.00	790,230.00	5.300	51.083	56.383
Delaware	2	3	5	918,599.00	614,251.00	1,532,850.00	33,000.00	239,603.78	272,603.78	17.800	14.360	32.160
Florida	4	12	16	267,736.55	670,014.80	937,751.35	119,079.00	323,623.80	442,702.80	17.800	99.718	117.518
Georgia	14	60	74	773,578.75	4,213,102.55	4,986,681.30	363,756.34	1,940,464.05	2,304,220.39	201.840	405.091	606.931
Idaho	5	3	8	701,577.14	970,750.06	1,672,327.20	271,000.00	487,520.00	758,520.00	99.360	58.500	157.860
Illinois	3	6	9	2,532,714.42	10,461,072.70	12,993,787.12	1,193,685.77	4,970,554.49	6,164,240.26	151.950	390.300	542.250
Indiana	7	4	11	797,430.00	4,331,318.80	5,128,748.80	302,300.00	2,144,211.00	2,446,511.00	30.230	101.850	132.080
Iowa	16	21	37	1,205,483.85	1,287,061.10	2,492,544.95	363,515.30	452,230.43	815,745.73	276.950	264.420	541.370
Kansas	9	16	25	2,588,112.76	5,462,843.96	8,050,956.72	393,670.22	1,119,584.15	1,513,254.37	131.475	158.430	289.905
Kentucky	5	8	13	526,300.71	598,514.90	1,124,815 61	232,998.59	303,075.21	536,073.80	44.625	70.060	114.685
Louisiana	7	15	22	581,366.08	1,011,103.27	1,592,469.35	219,688.06	487,828.37	707,516.43	95.610	121.320	216.930
Maine	3	.....	3	528,935.14	83,347.76	612,282.90	264,467.57	41,673.87	306,141.44	28.450	7.010	35.460
Maryland	4	24	28	132,541.22	4,417,820.09	4,550,361.31	60,454.06	2,139,986.31	2,200,440.37	6.340	175.070	181.410
Massachusetts	8	8	16	532,393.73	938,100.22	1,470,493.95	224,308.38	423,995.27	648,303.65	23.941	27.726	51.665
Michigan	20	10	30	1,669,982.45	1,483,893.31	3,153,875.76	789,834.48	665,042.70	1,454,877.18	161.725	71.725	233.450
Minnesota	27	15	42	1,688,592.85	1,613,859.41	3,302,452.58	687,047.58	730,778.21	1,417,825.79	572.105	127.805	699.910
Mississippi	26	4	30	804,727.29	231,861.33	1,036,588.62	335,390.87	123,901.90	459,292.77	242.210	15.080	257.290
Missouri	6	13	19	383,465.23	2,026,106.66	2,409,571.89	113,113.40	784,606.46	897,719.86	59.230	143.560	202.790
Montana	7	32	39	127,555.12	903,380.31	1,030,935.43	63,777.56	451,690.12	515,467.68	60.250	148.210	208.460
Nebraska	10	44	54	753,982.30	2,281,419.78	3,035,402.08	309,763.70	1,121,443.30	1,431,207.00	341.970	981.120	1,323.090
Nevada	8	15	23	504,556.93	970,636.58	1,475,193.51	252,278.47	468,172.68	720,451.15	92.300	150.783	243.083
New Hampshire	16	30	46	263,256.03	612,242.24	875,498.27	132,127.99	305,621.08	437,749.07	24.100	48.147	72.247
New Jersey	1	8	9	257,341.26	1,540,779.05	1,798,120.31	59,212.68	365,030.00	424,242.68	9.694	32.091	41.785
New Mexico	12	5	17	908,293.44	422,391.74	1,330,685.18	454,144.21	211,198.37	665,342.58	236.320	58.550	294.870
New York	8	22	30	716,174.11	3,164,633.74	3,880,807.85	358,087.05	1,575,566.87	1,933,653.92	41.350	116.940	158.290
North Carolina	21	19	40	601,808.50	1,341,822.97	1,943,631.47	201,196.41	405,652.86	606,849.27	179.282	157.754	337.036
North Dakota	23	19	42	420,671.34	492,138.22	912,809.56	210,335.65	223,170.21	433,505.86	324.810	324.170	648.980
Ohio	17	53	70	3,249,167.92	9,920,402.89	13,169,570.81	889,678.30	3,085,357.00	3,975,035.30	98.750	286.991	385.741
Oklahoma	4	7	11	375,131.55	1,228,238.29	1,603,369.84	147,229.37	584,101.52	731,330.89	30.092	62.368	92.460

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Projects Statement Approved by States—Continued

STATE	Number of Projects			Total Estimated Cost			Federal Aid Requested			Mileage Covered		
	Prior to June 30, 1918	Fiscal Year 1919	Total to Date	To June 30, 1918	Fiscal Year 1919	To June 30, 1919	To June 30, 1918	Fiscal Year 1919	To June 30, 1919	To June 30, 1918	Fiscal Year 1919	To June 30, 1919
Oregon.....	7	9	16	$ 961,814.94	$ 916,247.88	$ 1,870,062.82	$ 420,585.61	$ 430,365.97	$ 850,951.58	98.520	79.770	178.290
Pennsylvania...	16	27	43	3,812,824.80	9,026,044.21	12,838,869.01	1,181,130.00	3,766,063.99	4,947,193.99	118.113	202.880	320.995
Rhode Island..	2	2	4	126,362.51	269,972.72	396,335.23	46,497.13	109,603.26	156,100.39	4.790	7.040	11.830
South Carolina.	6	15	21	322,827.23	627,050.02	949,877.25	140,001.99	262,528.60	402,530.59	30.570	112.678	143.248
South Dakota..	7	7	14	249,621.17	518,417.17	768,038.34	114,805.19	247,406.39	362,211.58	60.270	121.660	181.930
Tennessee.....	4	3	7	275,267.64	471,071.46	746,339.10	134,129.29	237,147.88	371,277.17	28.400	39.611	68.011
Texas.....	68	11	79	3,993,884.06	743,116.60	4,737,000.66	1,703,239.35	208,478.09	1,911,717.44	990.282	76.736	1,067.018
Utah.....	7	3	10	447,651.85	772,013.27	1,219,665.12	223,825.91	386,006.63	609,832.54	237.490	89.150	326.640
Vermont.....	9	1	10	131,678.45	37,468.74	169,147.19	65,839.21	18,734.37	84,573.58	12.705	4.155	16.860
Virginia.....	10	30	40	403,018.91	1,900,006.68	2,303,025.59	187,344.32	945,742.52	1,133,086.84	31.376	164.358	195.734
Washington....	11	21	32	831,476.41	2,616,857.04	3,448,333.45	389,723.82	1,243,042.43	1,632,766.25	68.860	128.016	196.876
West Virginia..	20	25	45	802,033.36	1,537,428.41	2,339,461.77	202,951.71	607,485.57	810,437.28	56.990	77.222	134.212
Wisconsin.....	43	45	88	1,481,412.65	1,788,070.38	3,269,483.03	493,804.17	595,045.67	1,088,849.84	195.343	215.815	411.158
Wyoming.....	15	9	24	365,618.23	757,829.55	1,123,447.78	182,809.10	378,914.75	561,723.85	143.270	110.530	253.800
Total...	580	736	1,316	$42,278,770.38	$91,495,797.99	$133,774,568.37	$16,049,821.74	$38,664,397.41	$54,714,219.15	6,249.396	6,470.583	12,719.979

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Type of Construction

STATE	1917							
	Total Number of Projects 1917	Bituminous Concrete		Brick		Undetermined		
		Number	Miles	Number	Miles	Number	Miles	
California	2	2	6.790					
Pennsylvania	3			1	2.675	2	12.714	
Total	5	2	6.790	1	2.675	2	12.714	

STATE	1918																					
	Total Number of Projects 1918	Earth		Sand Clay		Gravel		Macadam		Macadam Mat Top		Bituminous Macadam		Bituminous Concrete		Concrete		Brick		Miscellaneous		Undetermined	
		Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles
Alabama	22			12	96.295	7	35.180	1	9.170			2	8.500										
Arizona																							
Arkansas	16					10	48.384	3	9.540	1	8.080	1	2.990	1	5.549								
California	1	1	15.940																				
Colorado	4	1	8.940													1	3.950			1	3.130	1	64.120
Connecticut	1															1	5.300						
Delaware																							
Florida	2			1	10.450													1	4.120				
Georgia	1			1	72.033																		
Idaho	3	3	54.360			1	5.000																
Illinois																							
Indiana																							
Iowa	7	4	104.080			2	30.170									2	5.070						
Kansas																							
Kentucky	2	1	10.191					2	5.340									1	3.890				
Louisiana	5	1	5.360			4	48.950							1	4.000								
Maine	3											3	28.404										
Massachusetts	6							1	3.240			2	2.487	2	4.526	1	2.182						

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Type of Construction—Continued

STATE	1918																					
	Total Number of Projects 1919	Earth		Sand Clay		Gravel		Macadam		Macadam Mat Top		Bituminous Macadam		Bituminous Concrete		Concrete		Brick		Miscellaneous		Undetermined	
		Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles
Maryland	3															3	6.340						
Michigan	7	1	46.820			2	22.105			1	5.983			1	2.000	3	12.915						
Minnesota	11	2	40.210			9	181.925																
Mississippi	4					4	40.410																
Missouri	2					1	6.540									1	7.500						
Montana																							
Nebraska	6	4	167.890	4	7.410	1	15.100											1	5.440			1	17.100
Nevada																							
New Hampshire	8					4	8.440							3	2.740							1	1.260
New Jersey	1																					1	9.694
New Mexico	3					3	40.020																
New York	6							1	11.440	1	1.060	2	6.070			2	7.510						
North Carolina	11	3	18.290	2	16.240	2	16.240									1	1.782					3	37.580
North Dakota	8	5	68.770			4	23.470																
Ohio	7															1	3.730	3	9.445			3	25.825
Oklahoma																							
Oregon	1													1	18.000								
Pennsylvania	5													1	7.450	3	13.444	1	4.186				
Rhode Island	1													1	3.640								
South Carolina	3			2	16.010									1	2.840	2	3.950						
South Dakota																							
Tennessee	4							3	26.530							1	1.870						
Texas	6									3	39.889					2	5.155			1	4.905		
Utah	1																					1	44.890
Vermont	4					4	4.355																
Virginia	7			1	8.033	1	3.510	3	8.874							1	3.070					1	4.380
Washington	7	1	5.220			5	31.160									1	3.500						
West Virginia	5													1	2.530	3	4.830	1	2.010				
Wisconsin	14	1	6.290			3	13.360	4	14.647							6	13.960						
Wyoming	4	4	43.750			1	4.750									1	5.000						
Total	212	32	596.111	23	226.471	68	579.069	18	88.781	6	55.012	10	48.451	13	53.275	36	111.058	8	29.091	2	8.035	12	204.849

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Type of Construction—Continued

STATE	1919																					
	Total Number of Projects 1919	Earth		Sand Clay		Gravel		Macadam		Macadam Mat Top		Bituminous Macadam		Bituminous Concrete		Concrete		Brick		Miscellaneous		Undetermined	
		Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles
Alabama	11	...	...	6	35.270	5	37.122	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Arizona	3	1	12.707	...	...	1	3.220	...	...	...	...	...	...	...	...	1	3.860	...	...	...	...	...	...
Arkansas	5	...	...	...	...	4	38.250	...	...	...	...	...	...	1	5.000	...	...	...	...	...	...	...	...
California	3	3	26.050	...	...	...	...	...	...	...	...	...	...	...	...	1	11.400	...	...	...	...	...	...
Colorado	2	1	19.014	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	21.000	...	...
Connecticut	1	...	...	...	...	...	...	...	...	...	...	1	7.830	...	...	...	...	...	...	...	...	...	...
Delaware	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	15.906	1	5.720	...	...	...	...
Florida	4	...	...	2	10.700	...	...	...	...	...	...	...	...	1	2.500	1	3.050	...	...	...	...	...	...
Georgia	23	2	19.540	20	209.521	...	...	...	...	...	...	...	...	...	...	1	6.520	...	...	...	...	...	...
Idaho	2	2	35.770	...	...	1	4.000	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Illinois	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9	65.357	...	...	...	...	...	...
Indiana	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Iowa	8	3	33.980	...	...	2	23.570	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	32.940
Kansas	7	...	...	...	...	2	19.299	...	...	...	...	...	...	...	...	3	19.749	2	1.982	...	...	...	...
Kentucky	3	1	7.756	...	...	...	...	...	...	1	5.000	...	...	...	...	1	6.383	...	...	...	...	1	1.660
Louisiana	13	...	...	...	...	12	103.178	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Maine	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Massachusetts	2	...	...	...	...	...	...	...	...	...	...	2	11.865	...	...	...	...	...	...	...	...	...	...
Maryland	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10	46.667	...	...	...	...	...	...
Michigan	22	...	...	...	...	9	44.418	1	4.232	2	10.658	...	...	1	1.215	7	25.220	...	...	...	...	3	16.292
Minnesota	13	4	53.310	...	...	9	166.370	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	20.400
Mississippi	11	2	27.546	...	...	9	63.480	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Missouri	6	...	...	...	...	3	43.440	...	...	...	...	1	2.790	1	2.200	...	...	...	...	...	...	1	9.390
Montana	4	...	...	...	...	4	21.210	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Nebraska	13	10	245.300	...	...	1	14.830	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	85.270
Nevada	14	6	36.680	...	...	6	73.700	...	...	...	...	...	...	...	...	2	14.740	...	...	...	...	...	...
New Hampshire	8	...	...	...	...	5	6.580	...	...	...	...	1	0.950	2	3.550	...	...	...	...	...	...	...	...
New Jersey	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	15.338	...	...	...	...	...	...
New Mexico	5	1	20.620	...	...	4	42.225	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
New York	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	19.060	...	...	...	...	...	...
North Carolina	15	1	17.600	7	65.809	1	3.100	...	...	...	...	2	16.684	...	...	3	8.710	...	...	...	...	1	7.480
North Dakota	14	13	232.850	1	3.500	1	5.460	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Ohio	18	...	...	...	...	...	...	3	13.710	...	...	...	...	2	9.390	1	4.020	4	25.650	...	...	9	44.650

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Type of Construction—Continued

STATE	1919																							
	Total Number of Projects 1919	Earth		Sand Clay		Gravel		Macadam		Macadam Mat Top		Bituminous Macadam		Bituminous Concrete		Concrete		Brick		Miscellaneous		Undetermined	
		Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles	Number	Miles
Oklahoma	4	1	27.410	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	2	17.340	...	.....	...	.....	1	2.040
Oregon	6	2	15.560	...	.....	2	9.330	1	2.750	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	1	18.800
Pennsylvania	24	...	.....	...	.....	...	.....	...	.....	...	.....	3	18.570	2	26.290	19	92.113	...	.....	...	.....	...	.....
Rhode Island	3	...	.....	...	.....	...	.....	...	.....	...	.....	2	3.190	1	5.000	...	.....	...	.....	...	.....	...	.....
South Carolina	6	1	3.530	3	25.090	1	2.140	...	.....	...	.....	...	.....	...	.....	1	2.120	...	.....	...	.....	...	.....
South Dakota	5	2	23.640	...	.....	3	28.270	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....
Tennessee	3	...	.....	...	.....	1	15.392	2	23.989	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....
Texas	40	2	21.140	2	26.280	14	165.692	...	.....	12	99.408	...	.....	...	.....	1	4.666	...	.....	2	8.756	8	144.235
Utah	3	2	58.900	...	.....	...	.....	1	9.280	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....
Vermont	3	...	.....	...	.....	3	8.830	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....
Virginia	16	1	6.750	3	18.314	2	10.982	4	16.720	...	.....	1	3.234	...	.....	2	10.777	...	.....	...	.....	3	19.970
Washington	6	...	.....	...	.....	5	26.707	...	.....	...	.....	...	.....	...	.....	1	3.526	...	.....	...	.....	...	.....
West Virginia	18	1	4.000	...	.....	...	.....	1	2.000	...	.....	3	10.230	1	2.960	10	19.105	2	1.710	...	.....	...	.....
Wisconsin	46	13	66.346	1	5.750	8	39.760	3	13.490	...	.....	1	2.410	...	.....	16	44.200	...	.....	...	.....	5	45.302
Wyoming	3	1	10.410	...	.....	1	4.120	...	.....	...	.....	...	.....	...	.....	1	8.000	...	.....	...	.....	...	.....
Total	445	76	1,026.409	45	400.234	119	1,022.675	16	86.171	15	115.066	17	77.753	12	58.105	102	467.827	9	35.062	3	29.756	39	447.429

NOTE.—The difference between the number of projects shown on this report and on the report of project agreements executed is due (1) to the omission of projects covering the erection of bridges only and (2) to the counting of projects twice where they contain two types of construction.

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required to be distributed to the States on the same basis as provided by the Federal Aid Road Act for the apportionment of the Federal aid appropriations. There has been allotted to the States 20,519 motor trucks and quite a number of miscellaneous articles of equipment suitable for road-building purposes. There was in the hands of the War Department in the United States and in France quite a large amount of additional surplus equipment suitable for use in road construction work, and the War Department signified that much of this would be turned over to this department.

At the close of the fiscal year about one-third of the number of motor vehicles allotted were actually in possession of the States, and only a very small list of other equipment, supplies, or materials were actually delivered. The total number of motor vehicles and amounts of other equipment and supplies that will eventually be made available for use by the States can not be stated.

FOREST ROAD WORK, 1919

The following tabulation is a summary of forest-road activities for the fiscal year ending June 30, 1919:

STATE	Engineering, Investigation, and reconstruction Surveys Completed.			Cooperative Agreements Executed.				
	Number	Miles	Estimated cost of construction	Number	Miles	Total Amount	Federal	Local
Alaska								
Arizona	9	204	$1,223,080	10	190	$1,019,695	$ 488,558	$ 531,137
Arkansas	5	94	444,856					
California	10	294	1,381,062	7	107	595,900	299,950	296,050
Colorado	10	237	1,077,450	9	194	700,833	517,785	183,048
Florida				1	27	90,000	43,000	47,000
Georgia	1	18	82,247					
Idaho	3	54	877,062	6	189	389,840	205,295	184,545
Minnesota				1	31	150,000	90,000	60,000
Montana	2	18	70,714	7	36	911,140	51,070	40,070
North Carolina	4	65	525,923					
Nevada	1	6	28,144	1	19	45,000	22,500	22,500
New Mexico	2	16	42,500	5	73	331,119	238,619	92,500
Oregon	3	119	1,037,232	12	238	1,541,550	729,075	812,475
South Dakota	1	31	104,400	3	60	78,400	63,200	42,200
Tennessee	5	73	570,112					
Utah	1	19	50,050	7	224	593,290	296,645	296,645
Virginia								
Washington	4	85	1,758,635	6	42	717,692	372,435	345,257
Wyoming	2	21	83,500	6	180	581,600	368,300	213,300
Total	63	1,354	$9,356,967	81	1,610	$7,746,059	$3,786,432	$3,166,727

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BUREAU OF PUBLIC ROADS
UNITED STATES DEPARTMENT OF AGRICULTURE

The Agricultural Appropriation Act of March 3, 1893, provided an appropriation of $10,000 for the establishment of an "Office of Road Inquiry" in the Department of Agriculture, to make inquiries in regard to systems of road management, investigate methods of road making, prepare publications, and assist agricultural colleges and experiment stations in disseminating information on these subjects. This was the beginning of the present Bureau of Public Roads. For the fiscal year 1897 the annual appropriation was reduced to $8,000, but a provision was added authorizing investigation of road making materials in the several States. Until 1900 the annual appropriation remained at $8,000, but the name "Office of Road Inquiries," was changed to "Office of Public Inquiries" in 1899. In 1901 the appropriation was increased to $14,000, and provisions were made for conducting experiments in Washington and elsewhere and for publication of the results so determined. In 1902 this appropriation was increased to $20,000, and the office was empowered to investigate the chemical and physical character of road materials. In the Agricultural Appropriation Act approved March 3, 1905, the name was changed to "Office of Public Roads," and a statutory organization was provided. Again, in the Appropriation Act of March 4, 1915, the name was changed to "Office of Public Roads and Rural Engineering," under which all work of an engineering nature in the Department of Agriculture was concentrated in this office. In the Agricultural Appropriation Act of July 24, 1919, the name was again changed to the present designation of "Bureau of Public Roads."

The work of the Bureau at the present time may be conveniently grouped into three general classes: (1) Administration of the Federal Aid Road Act; (2) Investigations and Research; (3) Educational or Extension Work.

Federal Aid Road Work.—The Postoffice Appropriation Act approved March 4, 1912, appropriated $500,000 to be expended under the supervision of the Secretary of Agriculture in cooperation with the Postmaster General in improving certain roads to be selected by them on the condition that the State or local subdivisions should furnish double the amount of money allotted by the Federal Government. This was followed by the Federal Aid Road Act, approved July 11, 1916, which authorized the Secre-

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tary of Agriculture to cooperate with the respective State highway departments in the construction of rural post roads on condition that the States or their local subdivisions shall match the federal funds at least dollar for dollar, and also maintain the roads so improved. This Act carried an appropriation of $75,000,000 for post roads available during a period of five years, in the amount of $5,000,000 for the first year, and in amounts increasing by $5,000,000 for each subsequent year. This Act further appropriated $10,000,000, $1,000,000 available each year during a period of 10 years for the survey, construction, and maintenance of roads and trails within or partly within the national forests.

This Act was somewhat broadened and the appropriation subsequently increased by an amendment carried by the Postoffice Appropriation Act approved February 28, 1919, which provided $50,000,000 to be immediately available and $75,000,000 available for each of the two fiscal years ending June 30, 1920 and 1921, and also $3,000,000 annually for forest roads for the fiscal years ending June 30, 1919, 1920, and 1921. Section 7 of this Act also provided for the transfer to the Secretary of Agriculture all available war material, equipment and supplies not needed by the War Department but suitable for use in the improvement of highways, and that it be distributed among the highway departments of the several States to be used on roads constructed in whole or in part by Federal aid, such distribution to be made upon a value basis, the same as provided by the Federal Aid Road Act of July 11, 1916.

The Federal Aid Road Act provides that "any State desiring to avail itself of the benefits of this Act shall, by its State highway department, submit to the Secretary of Agriculture project statements setting forth proposed construction of any rural post road or roads therein." Consequently, only projects submitted and recommended by the State highway department of the State in question can be given any consideration. Furthermore, in order to avoid haphazard construction and secure as far as possible a connected system of highways which would serve national as well as State needs, each State was required to submit a program designating a properly correlated connecting system of roads to which all the Federal aid available during the five-year period should be confined. These program maps are now being reviewed with a view to limiting the application of Federal aid to the more important roads of the State systems. After a project is approved by the Secretary of Agriculture, the State highway department then proceeds with the final survey, the detail plans and specifications are prepared, and a definite agreement is submitted and entered into between the State highway department and the Sec-

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retary of Agriculture, in the form of a project agreement, and the approval of the plans and specifications, whereby the amount of Federal aid funds approved for the project are definitely set aside in the Treasury. As the work progresses, monthly payments may be secured on vouchers submitted by the State highway department when approved by the District Engineer definitely in charge of the work for this Bureau.

To January 31, 1920, project statements had been entered into involving the construction of 23,356 miles of road at a total estimated cost of $287,445,875, and on which Federal aid was requested to the extent of $123,204,205. Project agreements had been entered into on this date for the construction of 10,410 miles of road at a total estimated cost of $145,485,078, and on which Federal aid was requested to the extent of $62,656,809.

Under Section 8 of the Federal Aid Road Act of July 11, 1916, provisions were made for the survey, construction and maintenance of roads and trails within or partly within the national forests, in cooperation with the State, Territory, or county. Under the provision of this Act up to November 1, 1919, construction work had been completed or was in progress on 982 miles of roads within or partly within the national forests, and plans had been completed for the improvement of an additional 924 miles, while additional plans for a large mileage were in various stages of development.

Investigation and Research Work.—During the past ten years more than 6,000,000 motor vehicles, including nearly half a million of commercial vehicles of various types, have been added to the traffic on our public roads. In conformity with these traffic demands, the amount of new construction and improvement has increased more than 500 per cent, without as yet having fully met the needs and requirements for better transportation facilities. This has thrown a tremendous responsibility on the road designers. Data on which to base calculations for the construction of the most serviceable, as well as economical, roadway has been almost entirely lacking. The research work of the Bureau has consequently been largely extended so as to develop the necessary fundamental data. These tests involve extensive investigations into the bearing value of soils as to road and bridge foundations, the effect and action of impact on the roadway, and the wearing resistance of modern road surfaces and pavements.

A special device has been developed which will measure with a great deal of accuracy the actual soil pressure whether under a road pavement or bridge foundation or behind a retaining wall. Means have also been perfected for measuring the force of impact of a rapidly moving truck. Consequently, a basis has been laid

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for investigating the effect of many unknown factors, in both truck and road design. Tests are also under way to determine the effect of modern traffic on various classes and types of road surfaces. For this purpose narrow strips 400 feet in length of the proposed types of pavements are laid and then subjected to accelerated wear by means of repeated passages of a specially designed vehicle. It is believed that these tests will soon supply a great deal of much needed data to the highway engineering profession as well as to the designers of motor trucks.

A large amount of research work is also conducted in the form of experimental road building and maintenance investigations. The laboratories of the Bureau are especially equipped for work of an investigative character, in addition to the routine testing. This work includes microscopic examination and classification of road building materials, research on dust preventives and road binders, bituminous and non-bituminous road material investigations, concrete investigations, and experimental work, looking toward the standardization and improvement of present methods of testing bituminous and non-bituminous road materials. Investigations and studies of the economic value and importance of our public roads and present methods and means of road transportation are also conducted.

During the fiscal year 1919, 263 samples were examined in the chemical laboratory, and 1,084 samples were tested in the physical laboratory. These samples came in varying numbers from 42 States and the Dominion of Canada. The petrographic laboratory examined 686 samples of road building materials during the year. Of the samples examined in the physical, chemical, and petrographic laboratories, 355 were materials for use in Federal aid construction. Investigations were also made in regard to the construction and maintenance of various forms of road construction. Rather extensive investigations of the industrial practices in the preparation of commercial broken stone aggregates were completed during the year. A study was made of a large number of brick roads through the Middle States, and a number of slag concrete roads in Ohio were also inspected during the year. An object lesson road was built of sand-clay construction in Pierce County, Georgia, and reports on county road systems were made for several counties in California. Approximately 26 miles of experimental road located in Alexandria and Fairfax Counties, Virginia, Montgomery County, Maryland, and in the grounds of the Department of Agriculture were maintained during the year.

Educational and Extension Work.—The educational or extension work may be divided into (1) reaching the people by means of lectures, addresses, the publication of bulletins, the exhibit of

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models, etc., and teaching them the economic value of improved roads and the efficiency of various types; (2) giving special advice and assistance, where the problems to be solved necessarily involve a knowledge of community and cooperative administration, and of methods of planning and financing a system of better roads. At times this work may include the planning in considerable detail of a prospective highway system for an entire county and outlining the means whereby it may be financed; and (3) actual demonstrations of construction or maintenance of particular roads under the supervision of an engineer from the Bureau.

Practical demonstrations by means of models and other exhibit materials were made in 35 cities during the year.

Lantern slides and moving pictures are used to a considerable extent in the educational work of this Bureau. The photographic files contain 18,951 negatives, 64,041 prints, and 10,614 lantern slides illustrating almost every phase of public road construction, maintenance and transportation. Sixty-eight lectures were delivered by representatives of the Bureau before various meetings and organizations during the year.

In addition to the road work carried on by the Bureau, a large amount of work is done by the Division of Farm Irrigation, the Division of Farm Drainage, and the Division of Rural Engineering.

Funds.—For the fiscal year 1919-1920 Congress appropriated funds for the Bureau as follows: Salaries, $113,640; inquiries in regard to systems of road management and for giving expert advice, $38,240.00; investigations of methods of road making and furnishing expert advice on road building and maintenance, $138,220; investigation of chemical and physical character of road materials, $47,020.00; for conducting field experiments, $60,000; investigations in regard to farm irrigation, $82,440; investigations in regard to farm drainage, $73,760; investigations of rural engineering problems, $25,000; general administrative expenses, $16,000; or a grand total of $594,320. In addition, the Bureau has available for carrying on the Federal aid road work three per cent of the $95,000,000 apportioned to the States for the fiscal year 1919, together with the unexpended surplus from a like percentage retained for administrative purposes from previous apportionments.

Personnel.—Chief of Bureau, Thomas H. MacDonald; chief engineer, P. St. J. Wilson; assistant chief engineer, E. W. James; general inspectors, T. Warren Allen, A. E. Loder, L. I. Hewes; engineer of tests, Albert T. Goldbeck; chief of irrigation, Samuel Fortier; chief of drainage, S. H. McCrory; chief of rural engineering, E. B. McCormick; assistant to the chief, C. D. Curtiss;

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district engineers, (1) Charles H. Pursell, Postoffice building, Portland, Oregon; (2) Charles H. Sweetser, Mills building, San Francisco, California; (3) Joseph S. Bright, Customhouse, Denver, Colorado; (4) E. O. Hathaway, Postoffice building, Minneapolis, Minnesota; (5) J. C. Wonders, Douglas County Courthouse, Omaha, Nebraska; (6) J. D. Fauntleroy, Wheat building, Fort Worth, Texas; (7) J. T. Voshell, Postoffice building, South Chicago, Illinois; (8) C. H. Mourfield, Bell building, Montgomery, Alabama; (9) G. H. Miller, Federal building, Troy, New York; (10) V. M. Peirce, Willard building, Washington, D. C.; (11) T. M. Keene, Missoula, Montana; (12) B. J. Finch, 406 Hudson building, Ogden, Utah; (13) E. S. Wheeler, Albuquerque, New Mexico; chief, F. C. More.

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ROAD BUILDING IN THE NATIONAL FORESTS

By JOHN L. COBBS, JR.

Road building in the National Forests has for its primary objects the facilitation of travel and the development of the resources. The National Forests have been set aside from what remained of the timbered portion of the public domain to provide for their permanent ownership and administration by the Government as public properties, serving many uses. Of these uses the most important are timber production, water conservation, live stock grazing and recreation.

The importance of the recreation resource deserves special emphasis at the present time, and in connection with the road building program. In the early days of the movement for National Forests, appreciation of the scenic beauties of the mountains, and a desire to safeguard and perpetuate them, had much to do with the support given the reservation policy. From the outset the value of the recreation resource was known and recognized by the Forest Service, but because of the isolation of the forests and the difficulty of travel in most of them, comparatively few people were able in the early days to see the varied attractions they contain. In the last few years, however, the construction of good roads, the development of automobile travel, and a growing desire of people to get out into the open has caused the forests to be visited by increasing thousands of vacationists from the nearby towns and hot, dry valleys as well as by travelers from distant States.

Located in the roughest, most mountainous sections, the National Forests afford some of the most magnificent scenery in the country, as well as a glimpse of the picturesque types that made up frontier life in the early days. A recent visitor who spent a summer in the forests aptly called them, "The poor man's playground," because of the lack of restrictive regulations and the economy with which he found it possible to make an extended trip. Splendid views of snow-capped mountains, incomparable trout fishing in ice-cold streams, companionship with the wild things of the woods, and, after the day's tramp, the indescribable comfort of lounging before a camp fire, watching the stars come out, as the long twilight deepens into dark—these are the things that have made visitors to the forests get the habit of coming back year after year.

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At the present time there are 151 forests, with a total area of 154,000,000 acres. A better idea of their size may be obtained if each forest is pictured as being about three-fourths as large as the State of Delaware, and if it is understood that all the National Forests combined are equal in area to that part of the United States, exclusive of Ohio, which is north and east of the southwest corner of Virginia.

The number and location of the forests in each State is as follows:

STATE	Number Forests	National Forest Land
Alabama	1	36,418
Alaska	2	20,574,543
Arizona	10	11,154,923
Arkansas	2	901,821
California	20	18,814,659
Colorado	19	13,280,832
Florida	1	308,268
Idaho	19	17,606,792
Maine	1	27,860
Michigan	1	89,466
Minnesota	2	1,044.233
Montana	18	15,957,196
Nebraska	1	205,944
Nevada	8	4,971,335
New Hampshire	1	332,778
New Mexico	7	8,294,222
North Carolina	1	79,461
Oklahoma	1	61,480
Oregon	17	13,118,680
Porto Rico	1	12,443
South Dakota	3	1,097,075
Utah	12	7,415.510
Virginia	2	209,657
Washington	11	9,940,372
West Virginia	1	13,318
Wyoming	12	8,384,174
Aggregate for the 151* National Forests	.....	153,933,460

*22 Forests in two or more States.

In addition to the National Forests there are 11 so-called "Purchase Areas," where the Government is buying land from private owners for the purpose of forming new National Forests. These are located as follows.[1]

[1]Land is also being purchased in Alabama, Arkansas, Maine and New Hampshire for inclusion in the National Forests of those States.

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STATE	Number Purchase Areas	Land Acquired Acres	Additional Area Appropriated for Purchase
Georgia	2	47,419	38,395
North Carolina	4	161,383	86,176
South Carolina	1	18,454	190
Tennessee	3	178,784	57,136
Virginia	3	102,652	19,846
West Virginia	2	77,850	14,859

The natural resources of the National Forests are in keeping with their great size. They contain a stand of timber estimated at 623,000,000,000 board feet, with a value of more than $570,000,000, range forage valued at about $58,000,000, and a large amount of extremely valuable water power. Each year from 1,250,000,000 to 2,000,000,000 board feet of timber, worth about $3,500,000 is sold by the Government to sawmills, this amount representing only a small part of the timber that is mature and ready for cutting. The fact that 12,592 separate sales were made in the fiscal year 1919, indicates the number of sawmills that are wholly or partly dependent on the National Forests for their timber supply. In many places the range on the National Forests, because of its value for stock raising, is of greater local importance than the timber. A large proportion of all the cattle and sheep raised in the West depends upon the National Forests for summer grazing. In 1919, 39,156 grazing permits, covering 2,135,527 cattle, 93,251 horses, 5,154 swine, 7,938,034 sheep, and 60,789 goats, were issued to stock owners.

The Forests are administered and protected by the Forest Service of the Department of Agriculture. The most important element in their protection is the prevention and suppression of forest fires. It is extremely desirable that the forest rangers be enabled to reach any part of the forests on short notice, for a forest fire, like any other, can most easily be controlled when it is small. The roads and trails within the forests not only furnish a means of transportation for fire fighters, provisions, and supplies, but are valuable also as bases from which fires can be fought, for a road, or even a trail, will often prevent a fire from spreading. On a forest which has a well developed system of roads and trails,

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fire protection is relatively easy, but where this is lacking fire fighting is an uphill game.

Travel in the National Forests has always been exceedingly difficult because of their location in the roughest and most inaccessible parts of the country. The construction of roads and trails involves the expenditure of large sums of money. At the outset many of the forests were almost entirely undeveloped and had practically no roads and very few trails. The problem of opening up ways of travel was most urgent, and road and trail work was among the first activities which the Forest Service undertook. Because of the high cost of road construction and the sparsely settled country, trail building took precedence, and the limited amount of money available for this purpose restricted the work to the most urgently needed trails. With increases in funds, however, the work has grown until on June 30, 1919, there were more than 25,000 miles of trail constructed by the Forest Service in addition to 30,000 miles of trail built by other persons.

The greater part of the timber on the National Forests is unmerchantable at the present time, because of its distance from market. Much of it, however, is so located that the construction of roads will make possible the utilization of large tracts either by small local interests or by large lumber companies.

The Government has not been the only sufferer from the lack of roads in the forests. It has happened at times in many of the National Forests that lands not chiefly valuable for forest purposes, and with a considerable agricultural value, have been included within their boundaries. As rapidly as possible, such lands, occurring for the most part in comparatively small areas, has been eliminated from the forests or opened for settlement under the Forest Homestead Act. Many of the older ranches and communities were established before the creation of the forests, so that practically all the forests contain small ranch or farm settlements, often located long distances from each other and from the nearest railroad or supply point. On some of the forests there are also well developed mining industries. All of these little communities and industries are entirely dependent for their success upon having roads over which their products and supplies can be hauled. The difficulty has been, and still is, how to provide the roads needed by both Government and settler.

As far back as 1909, Congress made provision that 25 per cent of the net receipts of the National Forests should be returned to the road and school funds of the various States in which the forests are located to reimburse the States and counties for the loss of taxes incurred by the presence of National Forest lands

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within their boundaries. This money is expended by the counties. In 1912, further provision was made by Congress for the expenditure by the Forest Service of 10 per cent of the net receipts of the National Forests in the survey, construction and maintenance of roads and trails within the forests. This is commonly known as the "Ten Per Cent Fund." It amounted to approximately $200,000 in 1912 and has gradually increased until now more than $400,000 a year is available. In 1916, Section 8 of the Federal Aid Road Act provided $1,000,000 a year for 10 years for the survey, construction, and maintenance of roads, trails, and bridges, in or partly within the National Forests. This appropriation is known as the "Section 8 Fund." Further help to National Forest road building was given in February, 1919, when Section 8 of the Postoffice Appropriation Act provided $3,000,000 a year for each of the fiscal years 1919, 1920, and 1921. The money provided under this Act is called the "Federal Forest Road Construction Fund."

The primary allotments of all road funds are made by States. The amount of ten per cent money available for a given State depends upon the receipts of the National Forests in the State. The Section 8 Fund is apportioned on the basis of the acreage of the National Forests in each State and the value of the timber and forage which the forests contain. The money available under the Postoffice Act is apportioned on the basis of the urgency of the needs for various projects, and ordinarily upon the condition that specified cooperation be obtained, although occasionally circumstances are such as to make it inequitable to require assistance from the State or county. If the condition cannot be met, the money may be made available for other projects in the same State or in other States.

The selection of all road projects to be undertaken on the National Forests is made by the Forest Service. In order that the needs of each forest may be known, a comprehensive working plan has been prepared showing the roads which will be required in the next 10 years to meet the needs and to develop properly each locality and community within each National Forest, taking into account the probable growth and development as far as it can be forecasted. The importance of each road and the order of its construction are determined by careful study made by the local representatives of the Forest Service. In making this study, such factors are taken into account as the amount and kind of traffic which exists at the present time and which could be expected in case of new construction, the needs which the road would serve, and the development of farm or ranch communities.

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The following table shows the amounts of each fund thus far allotted to the various States, including the fiscal year 1920:

	10 Per Cent	Section 8	Federal Forest Road Fund
Alaska	$ 52,789.70	$186,451.00	$ 59,000.00
Arizona	244,112.35	227,127.00	234,743.00
Arkansas	34,958.69	67,651.00	105,150.00
California	278,441.39	563,736.00	569,730.00
Colorado	227,593.41	252,506.00	430,770.66
Idaho	270,151.22	426,118.00	676,079.00
Montana	270,537.59	283,196.00	444,370.00
Nevada	61,799.88	76,769.00	90,424.00
New Mexico	149,477.71	160,678.00	246,325.00
Oregon	238,438.26	520,667.00	607,742.00
South Dakota	45,178.94	32,159.00	40,854.34
Utah	152,393.68	160,677.00	282,874.00
Washington	128,791.29	368,548.00	404,475.00
Wyoming	118,544.94	164,221.00	449,500.00
Florida	9,875.55		
Michigan	349.00		
Minnesota	9,194.23	43,961.00	108,800.00
Nebraska	7,672.19		
Oklahoma	3,317.06		
Porto Rico	.....	.....	.....
Alabama	62.22		
Georgia	746.15		
Maine	293.43		
New Hampshire	4,039.17		
North Carolina	3,753.26	95,594.00	321,050.00
South Carolina	128.20		
Tennessee	1,671.63		
Virginia	5,186.27		
West Virginia	580.58		

When the information shows that the road is immediately needed and the project is of primary importance, negotiations are begun to determine what coöperation can be obtained. The regulations for the Section 8 fund require 50 per cent cooperation under all ordinary circumstances. The funds, however, do not of necessity have to be expended within the forest boundaries. If the State or county authorities are willing and able to cooperate with the Forest Service, an agreement is drawn up providing for the necessary funds and specifying the type of road to be constructed. The procedure is the same in case of the Federal Forest Road Construction funds, except that cooperation is not necessarily required for projects lying entirely within the forest boundaries.

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THE REAL WAY TO SEE THE WEST.
Hundreds of camps like this one are to be found in the National Forests during the summer. Road building by the Forest Service is opening up large areas of attractive country to tourists



Snagging a big 'un in the Pike National Forest, Colorado

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Independence Pass auto road along the Roaring Fork River. Sopris National Forest, Colo.

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On projects where the cost is comparatively high, or where difficult engineering problems are involved, the survey and construction is carried out under the supervision of the Bureau of Public Roads of the Department of Agriculture. On December 1, 1919, there were 85 such projects under construction or recently completed, aggregating 982 miles, for which the estimated cost was $6,672,159. In addition, surveys and plans were being made for 61 other projects with a total of 1,388 miles. On the smaller and less expensive projects the work is supervised by the Forest Service, which in 1919 handled approximately 350 miles of new road construction and a considerable amount of road maintenance and trail building. Construction in either case is done by contract or by day labor, as circumstances dictate.

At the present time there are 44,000 miles of road within the National Forests, of which 3,620 miles have been constructed by the Forest Service. These figures include roads of all kinds, from improved highways down to the roughest kind of mountain trail, and show an average of something less than 300 miles of road per forest. Since many of the roads skirt the outer edges of the forests or traverse valleys where a large amount of the land is in private ownership, it often happens that large areas are entirely without any roads at all. At the best, the present roads are only a beginning. Those to be constructed under the proposed 10-year plan will extend the present system and will form a skeleton structure of the roads which will eventually be needed to develop the forests properly.

In addition to the development which will follow the construction of the roads, tourist travel in almost every case will be greatly facilitated. The National Forests contain within their boundaries some of the finest mountain scenery on the continent, the streams are stocked with trout and other game fish, and in many places big game shooting can be had in season. These attractions help to make the National Forests ideal playgrounds and their use for this purpose is rapidly increasing. Every effort is made by the Forest Service to render the forests popular and attractive to the public. Camping grounds are set aside for the use of tourists and other visitors. Fireplaces and rest houses are erected for their convenience. There is no charge for camping or touring in the forests. Firewood may be had free and no charge is made for grazing the horses used by campers. In a number of places summer home sites have been laid out which can be leased at a moderate annual rental by persons who desire to erect cottages.

In connection with the road construction, the Forest Service

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plans to issue road logs for all important roads and will post cautionary and informative signs along the roads in the Forests. Regular reports on the condition of roads are received at the office of many Forest Supervisors and made available to the public. For some of the Forests, maps have been prepared showing the principal routes of travel, the best trout streams, where game can be found, and other information needed by the tourist. These maps, together with an ordinary "bump" of direction and a little horse sense, enable tourists from distant states to find their way about quite as readily as if led around by a high-priced guide. Most of the Forests have a well developed telephone system by which communication may be had with the outside world. Visitors may always obtain permission to use the telephones and will find that the Forest Rangers are glad to give them full information regarding the best camping places, as well as to extend other little courtesies which mean much to a stranger in a strange land.



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ROADBUILDING IN NATIONAL PARKS

The National Park Service was created by the act of Congress of August 25, 1916, as a bureau of the Department of the Interior and was charged with the supervision, management and control of the National park areas. Prior to this legislation each park was a separate unit reporting direct to the Secretary of the Interior. Funds for the administration, protection, maintenance and improvement of the parks and monuments are appropriated annually by Congress.

The National Park system now embraces 18 National parks and 23 national monuments. The total area of the National parks is 6,872,585 acres, or 10,739 square miles. The total area of the national monuments is 1,235,840 acres or 1,931 square miles. All these reservations, except the Lafayette National Park in Maine, lie west of the Mississippi River. One National park is in Alaska and one is in Hawaii.

All the National parks and monuments are open to vehicles of all kinds and facilities are provided so that tourists may visit and enjoy the parks in any manner they choose. There are now in the national parks over 900 miles of roads which are safe for motor-driven vehicles.

Of $196,703.03 of revenue received from all sources in national parks during 1919[1], $133,947.50 was received from licenses issued for automobiles and motorcycles, which are turned into the United States Treasury.

The receipts collected by parks[2] were:

Name of Park	1919
Yellowstone	$71,337.50
Sequoia[3]	4,134.50
Yosemite	23,474.00
General Grant	1,504.00
Mount Ranier	22,167.00
Crater Lake	7,991.50
Mesa Verde	674.00
Glacier	2,665.50
Total	$133,947.50

The following table gives some interesting statistics concerning the National parks:

1 Received in Washington, to and including October 10, 1919.
2 No licenses required for Wind Cave, Hot Springs, Platt, Hawaii, Lassen Volcanic, Sully's Hill, Rock Mountain, Grand Canyon, and Lafayette National Parks. No roads in Mount McKinley Park.
3 License required only for Giant Forest Road.

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National Park Statistics

NATIONAL PARK	Location	Road Mileage	Road Maintenance Funds Fiscal Year 1918-1919	Road Maintenance Funds Fiscal Year 1919-1920	Area Square Miles	Area Acres	Visitors Season 1919	Private Automobiles Entering 1919
Hot Springs	Arkansas	8	$ 1,092.67	$ 3,000.00	1⅓	911.63	[3]160,490	(1)
Yellowstone	Wyoming, Montana, Idaho	300	143,000.00	109,000.00	3,348	2,142,720	62,261	10,737
Sequoia	California	46	5,682.83	7,940.00	252	161,597	30,443	3,852
Yosemite	California	138	58,200.00	70,710.00	1,125	719,622.4	58,362	12,109
General Grant	California	10	1,484.79	2,850.00	4	2,536	21,574	3,366
Mount Rainer	Washington	30	9,658.77	10,500.00	324	207,360	55,232	10,434
Crater Lake	Oregon	57	1,800.00	16,095.00	249	159,360	16,645	4,637
Wind Cave	South Dakota	6	1,133.83	450.00	17	10,899.22	26,312	8,240
Platt	Oklahoma	7	2,539.90	555.00	1⅓	848.22	25,000	(1)
Sully's Hill	North Dakota	(1)	None	None	1¼	780	4,026	(1)
Mese Verde	Colorado	37	2,400.00	1,100.00	77⅝	48,966.4	2,287	436
Glacier	Montana	130	19,260.34	23,500.00	1,534	981,681	18,956	1,697
Rocky Mountain	Colorado	[2]7	1,074.70	1,330.00	397½	254,327	[3]169,492	[3]33,638
Hawaii	Hawaiian Islands	(1)	None	None	118	75,295	(1)	(1)
Lassen Volanic	California	(1)	None	None	124	79,561.58	2,500	(1)
Mount McKinley	Alaska	None	None	None	[3]2,200	[3]1,408,000	(1)	(1)
Grand Canyon	Arizona	103	.....	18,350.00	[3]958	[3]613,120	37,745	1,575
Lafayette	Maine	3	2,958.07	1,800.00	[3]8	[3]5,000	64,000	[3]7,000
Totals	.....	882	$250,285.90	$267,180.00	10,739	6,872,585.45	755,325	97,721

[1]No record. [2]54 additional miles of county and state roads. [3]Estimate.

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Park Highway Systems

The National Park Service has shown intense interest in the development and improvement of automobile highways leading from large centers of population to the parks and in the development of an interpark highway system. The Director of the National Park Service in his annual report for 1919 to the Secretary of the Interior says in this connection:

"The prospects for the establishment of the national park-to-park highway as a great system of interstate routes in the West have grown brighter almost daily since the opening of the past touring season. The immense value of such a system has come to be appreciated more this year than ever before. There is now a wide demand for the highway, where prior to this year its importance was seen by relatively few communities, most of which were on direct routes to the national parks, and had unusual opportunities to observe its growing volume of motor travel.

"The unprecedented travel of the season just closed, however, demonstrated to cities and towns far distant from the national parks that these great playgrounds were the most powerful magnets for motoring tourists that the western country possessed, and that if this travel was to continue and grow in volume roads to and between the national parks must be made the object of special attention by the various States and all of their local subdivisions.

"Another reason for the unusual interest that is being taken in the park-to-park highway plans is found in the operation of special transportation service between certain parks during the past summer. The Yellowstone Park Transportation Company and the Glacier Park Transportation Company coöperated in the operation of an automobile line between Yellowstone and Glacier National Parks, making an overnight stop in Helena. The maintenance of this service naturally attracted attention to the feasibility of making the trip between the two parks and many private cars followed the automobile stages. Likewise an attempt to maintain service between Denver, Rocky Mountain Park, and Yellowstone Park by the owners of the transportation lines of these two parks by way of Cheyenne, Casper, Thermopolis, and Cody, Wyo., stimulated extraordinary interest in that section of the interpark highway."

Sections of the highway between Rocky Mountain and Yellowstone Parks that were in bad condition prevented the continuation of the regular automobile service throughout the season, but this

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service was maintained between Yellowstone and Glacier Parks for a considerable period of time. * * *

"Of course hundreds of motorists traveling in their own cars visited more than one park during the summer, and numerous parties toured every big park of the system.

"The program covering the expenditure of hundreds of millions of dollars by the Federal Government in coöperation with the States in the building of highways was adopted soon after the close of the war, and the same legislation contained a provision for a comprehensive improvement and extension of roads in the national forests. The road-building program of these measures is to be carried out over a period of years, and in my opinion a similar program, with the appropriation of approximately $1,000,000 a year for extending the existing road system of the parks and undertaking the paving of such parts of this system as may be advisable, should be adopted by Congress.

"There are a number of important new highway construction projects ready to be undertaken, all necessary surveys and estimates having been completed and approved. This is the time for the Nation to adopt a broad-gauge road extension and paving program for the national parks, and I sincerely trust that it may be approved by Congress in connection with our budget for the next fiscal year.

"The evolution of the automobile camp has been a source of great interest to me. I have seen it grow year by year from a modest space in a park of a thriving western city to large and bountifully supplied camps in hundreds of towns and cities. It is now an institution of the West and particularly of the park-to-park highway."

National Park Service

Evidence of the further interest of the Department of the Interior in the development of park-to-park travel by motor transportation is contained in Secretary Lane's annual report of 1919, extracts from which are as follows:

The tremendous popularity of our national parks was fully attested by the unprecedentedly large number of visitors during the 1919 season, which closed about the middle of September. Freed from the restrictions against war-time travel, which had been a war necessity, the appeal of the great natural attractions of the parks was irresistible and the response spontaneous. The national parks became the cynosure of the eyes of a war-weary and hard-worked people, bent on taking a holiday where they could derive the greatest benefits. There the refreshing atmosphere of the great Out of Doors, the soothing diversion of the

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natural scenery, and the specific qualities of the fresh air brought mental and physical relief to hundreds of thousands. When one considers that travel to our national parks and monuments exceeded 810,000 visitors—over 755,000 to the parks and over 55,000 to the monuments—it is evident that the recreative value of the parks is a tremendous factor in the health, wealth, and contentment of the Nation.

Park -to-Park Highway

The immense value of a park-to-park highway is becoming yearly more apparent. Where in former years relatively few communities were in favor of it, now there is a wide demand for such a connecting link between these scenic areas. Motorists find that in almost every town along the routes from their homes to the parks or between the reservations themselves a well-kept automobile camp is established which they are privileged to use free of charge. Many of these camps are adequately equipped and wood is nearly always available; of course, small charges are made in places to cover the cost of wood or other fuel. The automobile camp of the western towns and cities is now an institution and a particularly enjoyable adjunct of park-to-park travel. The first extensive park-to-park trip to be made by using the special transportation facilities provided by the Yellowstone Park Transportation Company and the Glacier Park Transportation Company was made by a party organized by and under the guidance of the Brooklyn *Eagle,* which undertook the trip in July and early August. The trip was a great success.

The director of the National Park Service covered a number of sections of the park-to-park highway as it could be designated in Oregon, Washington, and California, between Sequoia and Mount Rainier National Parks, and found most of them to be in reasonably good condition and available as links in the National park highway system. There are many sections of this proposed system so situated as to require no special designation, but again there are other near-by routes that might be selected. Designations have been made by the National Parks Highway Association with headquarters in Spokane, Wash., with particular emphasis on the sections between Yellowstone, Glacier, Mount Rainier, and Crater Lake National Parks. The Yellowstone Trail Association at Aberdeen, S. Dak., and the National Park-to-Park Highway Association, which has its headquarters at Cody, Wyo., have designated other routes.

When the idea of an interpark highway was first suggested it was conceived as a great circular route, combining the major

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national parks of the West, but beginning and ending in Denver, Colo. It may, however, be necessary to make a number of alternative routes in the system and a few of what might be termed small circle tours for the use of motorists. To complete the big tour in one season will be difficult. A conference was held in Yellowstone Park on August 10 and 11, at which 12 States were represented, for the purpose of discussing ways and means of expeditiously advancing the selection and improvement of the park-to-park highway and coöperating with the National Park Service in the encouragement of travel to the parks. This conference was organized as the National Parks Touring Association, to secure the "coöperation and coördination of all State and National highway associations with a view to a composite road system leading to and connecting the National parks." This organization is practically completed. L. L. Newton, of Cody, Wyo., is general secretary of the association. The men who attended this conference have had a particularly broad experience with good-roads movements in the Western States and an intimate knowledge of the requirements of the situation.

States Coöperating in Road Building

Some of the States are coöperating with the park administration by providing highways to the park entrances. A particularly conspicuous example of this is found in California, where Tulare county has paved the highway to Three Rivers, the junction of the entrance roads to Sequoia Park; and the State has recently passed a $40,000,000 bond issue containing an item of $300,000 for completing the paving of the roads to the park line. At Yosemite Park the construction of a paved highway from Merced to El Portal is being promoted by California business men. In Oregon the State and the Federal Government are constructing a highway that will later be paved from Medford to the west entrance of Crater Lake Park, some 72 miles. Washington is coöperating by issuance of bonds to pave the entrance roads to Mount Rainier Park, and Colorado is improving the entrance roads to Rocky Mountain National Park. Montana also is doing its share, with the coöperation of several counties, in improving the roads approaching the Yellowstone and Glacier Parks; and Wyoming is rebuilding two roads leading to the south entrance of the Yellowstone. These last two States are concentrating a large portion of their highway funds on these park approaches.

Park Road Construction a Vital Necessity

Practically no money, however, has been available for road extensions in the National parks this year with the exception of

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a fund provided to complete the rebuilding of the El Portal Road in Yosemite. Work on the highways within the parks has been confined entirely to ordinary maintenance and repair. In some of the parks the funds available have not been sufficient even to prevent perceptible depreciation. An appropriation of approximately $1,000,000 a year for a period of years for extending the existing road systems of the parks is one of their most vital needs. The Government is coöperating with the States with an expenditure of millions of dollars in the building of highways, which includes at the same time a program for the development of roads through the national forests; the main scenic features of the parks should in a similar manner be made available to the traveling public and the road systems within the parks should be developed and enlarged to accomplish this. Our motorists should at least find as good roads within the parks as they find in the approach roads to the parks which the States and counties furnish, particularly as the Government exacts an entrance fee from the automobile owners for using the park roads.

The need for paving roads is particularly pressing in Yellowstone, Yosemite, Crater Lake, and Mount Rainier. All one-way roads used for two-way travel should be widened to accommodate that double travel.

New Road Construction in Prospect

The National Park Service has a number of important new highway construction projects ready to be undertaken as soon as funds are provided. Surveys and estimates of cost have been made, and work can be started without delay. A transmountain road in Glacier Park to connect the east and west sides of the park is one of the most interesting, since it will connect the two sides of the park now practically separated from each other by the mountainous masses of the Continental Divide; unless a round-about way is taken the east side of that park is isolated from the west side; only parts of this wonderful park area have been made accessible. Other projects of first importance are a road connecting the Yosemite Valley with Tenaya Lake on the Tioga Road—a road in Sequoia Park to connect the valley of the Middle Fork of the Kaweah River with the Giant Forest. At the Grand Canyon a road along the rim from El Tovar to Grand View is an immediate necessity, and the Carbon River Road along the river of that name to the mouth of the Carbon Glacier in Mount Rainier Park should be undertaken as soon as possible. In Rocky Mountain Park what is known as the Trail Ridge Y route demands recognition as an important road project. Other

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important road projects have been studied and planned and will be submitted for the information and action of Congress in due time. Perhaps the most important engineering project completed during the year was the construction of the new road in the Gardiner River Canyon, in the Yellowstone.

New Trails.—Hand in hand with the development of roads goes the construction of new trails. Trail surveys and studies conducted by the engineering department included projects in the Grand Canyon Park and the Belley River district in Glacier Park. The allurements of the trails are strongest in the true lover of nature, and the construction of such leaders into the innermost recesses of our park wonderlands, where their glories may be enjoyed quietly and uninterruptedly, is an important part of national-park administration and development.



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STATE FINANCING OF ROAD BUILDING

Twenty-seven years ago New Jersey put into practice the principle that it is the State's duty to help in the construction and maintenance of the more important roads. The first State aid law enacted by its legislature provided an annual appropriation of $75,000 with which to pay one-third of the cost of roads constructed under State direction. This year, New Jersey is providing $5,800,000 for State road purposes.

Every State in the union, except three—Kansas, Mississippi and South Carolina—are now following New Jersey's example by contributing money from State funds toward the construction and maintenance of State or State-aid roads.

The problem of providing these funds has taxed the ingenuity of legislators, for the exchequers of many of the States are woefully depleted most of the time. To provide adequate funds for roads constitutes one of the most important and complex problems with which State legislatures have to deal. Various methods of levying taxes, both direct and indirect, and of providing funds for this purpose are now on the statute books of the different States.

State Funds

During the present year, there is available for expenditure from State funds, to meet Federal and local contributions in the various States, approximately $177,500,000, almost three times as much as was expended from the same source and for the same purpose during 1918. These funds are derived from: 1st, special State-wide road taxes; 2d, legislative appropriations from general or statutory funds; 3d, State bonds; 4th, automobile revenues; and 5th, various other miscellaneous sources.

A State-wide road tax varying from 1/10 to 4 mills is now levied in 22 States, yielding approximately $20,000,000 a year. The States in which a State-wide road tax is levied, the rate of the tax, and the amounts produced during 1919 are shown approximately as follows:

Arizona, 1-mill	$900,000	Nevada, 7/10-mill	$130,000
Colorado, ½-mill	600,000	New Jersey, 1-mill	3,000,000
Florida, 2-mill	750,000	New Mexico, 4¼-mill	1,620,000
Idaho, 2-mill	1,650,000	Oregon, ¼-mill	250,000
Indiana, 39/100-mill	2,520,000	Oklahoma, ¼-mill	300,000
Kentucky, 3/10-mill	600,000	Rhode Island, 3/10-mill	240,000
Maine, 1-mill	500,000	South Dakota, 1/10-mill	120,000
Louisiana, ¼-mill (est.)	350,000	Tennessee, 1-mill	1,250,000
Minnesota, 1-mill	1,550,000	Vermont, ½-mill	128,700
Nebraska, appropriation from 3-mill	1,546,000	Virginia, 1-mill	*1,000,000
Nebraska, 1/5-mill	110,000	Wisconsin, ½-mill (est.)	1,700,000

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In two additional States, Ohio and Washington, a State-wide road tax is levied, but the proceeds are deposited in the State treasury and must be specifically appropriated before they become available for road work.

A total of approximately $53,000,000 was raised in 18 States by legislative appropriations from general and statutory funds during the year, which is about twice as much as was obtained by the same method during 1918. A list of the States making appropriations and the amounts for the year are indicated approximately as follows:

Arizona	$530,000	New York	$17,242,561
Connecticut	3,454,500	Ohio	5,590,000
Illinois	937,678	Pennsylvania	8,600,000
Massachusetts	491,025	Rhode Island	355,000
Maryland	400,000	Vermont	260,000
Maine	300,000	Virginia	*485,000
Missouri	2,610,000	Wisconsin	850,000
Michigan	6,386,000	Washington	4,740,000
New Hampshire	375,000	Wyoming	300,000

Funds derived from State road bond issues in 12 States amounted to approximately $53,000,000 during 1919, which is over four times as much as was produced from the same source in 1918. The funds indicated below represent the approximate amounts available for expenditure from bond funds during the year 1919. These amounts do not in all cases include the total issues:

California	$8,000,000	Oregon	$4,560,000
Delaware	3,500,000	Oregon	1,420,000
Illinois	12,000,000	Pennsylvania	12,000,000
Idaho	200,000	South Dakota	1,000,000
Maryland	4,500,000	Utah	3,000,000
Massachusetts	1,000,000	Wyoming	1,000,000
Nevada	1,000,000		

There are 36 States in which revenues derived from the registration of automobiles were used this year in whole or in part for State construction or maintenance, or both, principally for maintenance. The total fund resulting amounted to approximately $47,000,000, which is about 25 per cent more than was produced from the same source during 1918.

There are several States, including Missouri, New York, Ohio, and Washington, where the automobile funds are used for State road purposes, but in which the State funds are deposited in the State treasuries and appropriated before they can be used. In Utah, the automobile money is used to pay interest and to retire State bonds. There are a few other States, including Kansas, Louisiana, Mississippi, South Carolina, and South Dakota, in which the automobile money is used for road work by the counties without State direction.

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A list of the States, the percentage of the automobile money and the approximate amount used by the States for roads are indicated as follows:

Alabama, 77%	$600,000	Montana, 75%	$360,000
Arizona, all net	164,000	Nebraska, 75% (estimate)	2,000,000
Arkansas, appropriation from	950,000	Nevada, all net	30,000
California, 50%	1,800,000	New Hampshire	500,000
Connecticut, all net	1,000,000	New Jersey, all net	2,850,000
Colorado, 50%	205,000	New Mexico, all net	140,000
Delaware, estimated	250,000	North Carolina, all net	1,300,000
Florida, all net	425,000	North Dakota, from net	150,000
Georgia	2,000,000	North Dakota, 5% of balance	250,000
Illinois, appropriation	7,500,000	Oregon, 75%	1,700,000
Iowa (estimate)	3,000,000	Pennsylvania	5,000,000
Idaho, 50%	150,000	Rhode Island, all net	375,000
Indiana, all net	2,500,000	Tennessee, all net	400,000
Kentucky, all net	700,000	Texas, 50%	1,250,000
Maryland, 4/5 (estimate)	1,500,000	Vermont, all net	450,000
Massachusetts, all net	2,300,000	Virginia, all net	*1,350,000
Michigan, 50%	1,000,000	West Virginia, all net	1,000,000
Minnesota, all net	1,000,000	Wisconsin, 75%	1,500,000

* 1920 figures.

There are five States in which State road funds, amounting in all to about $4,000,000, were derived from special sources, such as internal improvement funds, State income tax, tax on gasoline, etc. A list of the States and the amounts derived from each of these special sources during the year are as follows:

Colorado, internal improvement fund	$150,000	Nevada, appropriation and misc.	$250,000
Delaware, Dupont fund	2,500,000	Oregon, 1 cent per gallon on gasoline and ½ cent per gallon on distillates	400,000
Delaware, State income tax	150,000		
Indiana, State inheritance tax	500,000		

A well-conceived system of State or State-aid roads will carry a larger volume of traffic proportionately than any other roads in the State. The building of such a system, therefore, materially reduces the cost of transportation, thus benefiting both producer and consumer. Whether one lives in the country or in the city, he is benefited by the improvement of such roads either directly or indirectly. Hence, it would appear that the funds necessary to produce these roads should be raised by taxation levied on everybody in proportion to their material wealth.

The best and most equitable form of State taxation for road purposes would, therefore, appear to be a State-wide tax levied on all taxable property. Ten years ago, none of the States levied such a tax, but as indicated now there are 23 States in which taxes are so levied.

Another plan of financing State road improvements, to which no legitimate objection can be raised, is for the State to capitalize its receipts from a State-wide tax, by issuing bonds, using the tax receipts each year to pay interest and retire the bonds as they

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may become due. By this method a State can speed up its road-building program and obtain the use of the roads sooner than would otherwise be the case, thus securing benefits from the improvements while they are being paid for.

Auto Money for Maintenance

The maintenance of roads, especially the trunk-line State and State-aid roads, is recurringly met best by the funds derived from automobiles and other road users. There are several States, however, in which the automobile money is being used for construction purposes, and a few States in which it is being utilized to finance State bond issues. If the automobile money is so used, the States lose their best and most reliable source of income for maintenance.

The entire history of road legislation has demonstrated conclusively that it is far more difficult to secure adequate funds for maintenance than for construction. It would seem, therefore, that as the automobile money is constantly increasing, with the multiplying of traffic and mileage of improved roads, it should be reserved as a maintenance fund instead of using it to finance construction or bond issues, which ought in all cases to be taken care of by State-wide taxes or by appropriations from the general treasury of the State whenever the funds in such treasuries will permit.

The idea of using the automobile money for paying the interest and for liquidating State bond issues originated in Maine a few years ago as a matter of expediency. It was found in that State that it was difficult to raise enough money to finance the beginning of a trunk-line system of State highways which was greatly needed. It was proposed to use the automobile money for this purpose, or so much of it as might be necessary, applying the balance to the maintenance of State and State-aid roads. Two million dollars worth of bonds were issued, and the automobile funds, which of course have increased, proved to be sufficient to pay the interest and maintain the existing roads which concerned the State.

Another issue of $10,000,000 has been voted in Maine, and the automobile money will not be sufficient to pay the interest, retire the bonds, and maintain the State system. Hence, it is planned to use the proceeds of the 1-mill State-wide tax for retiring the bonds and to retain the automobile money for maintenance.

There are a number of States in which the only State funds available for State road purposes at present is the automobile money. For a State which finds great difficulty in inaugurating

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a State road-building program, it might be a policy of expediency to use a portion of the automobile money for construction, but reserving as much as may be necessary for maintenance. As the mileage of improved roads increase, a larger and larger amount of automobile money should be reserved for maintenance. But this plan should also include a State-wide tax with which to produce a sufficient amount of money to meet Federal aid in the building of a system of State highways and also local contributions to apply to State aid construction and maintenance.

Many of the States at present are providing little or no State money for these purposes and are merely the agents for the counties in dispensing Federal money. Certainly, if the Federal Government can see its way clear in helping the States finance a State system, it follows that the State itself with State funds should be willing to match Federal dollars with State dollars and not endeavor to match Federal money with county, township or district contributions.

Furthermore, the plan of using local funds to match Federal funds can never provide a reasonably connected system of highways. A large number of States have tried the plan of compelling local communities to match State funds and in nearly every case it has resulted only in haphazard, scattered, piecemeal construction, without any definite plan or any hope of ever securing within a reasonable time a connected system.



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HIGHWAY MANAGEMENT AND FINANCING IN THE VARIOUS STATES

ALABAMA

State Road Legislation

Under a new State highway law, passed by the legislature of Alabama in 1919, the State highway commission consists of the senior professor of civil engineering in the Alabama Polytechnic Institute, the State geologist and a member appointed by the governor from each of the ten congressional districts of the State. The commission deals with matters of general policy and acts for the highway department in all its relations with the governor and the legislature. The State highway engineer is chosen by the commission and holds office at their pleasure, but must be a competent engineer with six years' experience in actual charge of engineering work, not less than three of which shall have been in charge of highway construction. He is required to make a general highway plan of the State, collect information, determine the character and supervise the construction of roads built by the State and those built with the aid of the Federal Government.

The law provides that the State highway commission shall construct roads that lead from county seat to county seat of the various counties over the most direct and feasible routes, and for an equitable division of funds, labor and time between the various counties in the construction of such roads.

In order to receive aid from a State a county does not necessarily have to appropriate any money, but the State highway commission may condition an appropriation of a sum of money for road construction in a county upon the county's appropriating a sum to be fixed by the commission. Under the old law contracts were awarded in the name of the county; under the new law all contracts will be made by the State of Alabama. The State has authority to maintain any road constructed by the State with State funds.

Local Road Legislation

An elected board of county commissioners, consisting of the probate judge and four others, has jurisdiction over local roads, but boards of revenue or like boards may be created by special statute to take the place of boards of county commissioners. A

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supervisor of roads for an entire county may be appointed by the board. The board divides the county into road precincts and appoints a road overseer for each precinct. Road taxes may be worked out in counties having less than $100,000,000 assessed valuation.

Bond Legislation

On September 27, 1919, the legislature passed an act authorizing an election 90 days or later after the adjournment of the legislature, to amend the State constitution so as to permit the issuance and sale of $25,000,000 in State road bonds with which to build a system of State roads. Interest on these bonds are to be paid from the revenue derived from the sale of motor vehicle licenses. From this fund there shall also be created a sinking fund, as well as a fund for the maintenance of the roads.[1]

The court of county commissioners and board of revenue of any county may order an election on the issuing of county bonds to build roads or to pay debts created for the building of roads. After an election is held, another such election shall not be held within one year. A majority vote is necessary to carry. The amount of bonds shall not exceed 3½ per cent of the assessed value of property and shall bear not to exceed 5 per cent interest, shall be sold for not less than par value, and shall run for such time as may be fixed by the court of county commissioners and board of revenue. No specific provision is made by law for retiring the bonds, and this matter presumably is left to the discretion of the court of county commissioners and board of revenue.

Convict Labor Laws

The convicts of any county or municipality may be worked upon the public roads, bridges or ferries of the county under the direction of the court of county commissioners, or they may be hired to other counties. State convicts may be hired by a county.

Automobile Registration

Automobile licenses are issued by the probate judge of each county, who sends 20 per cent to the treasurer of the city, town or county where the licensee resides, 77½ per cent to the State treasurer, and retains 2½ per cent as commission.

License fees for private cars are: Under 25 h. p., $11.25; 25-30 h. p., $18.75; 30-40 h. p., $26.25; 40 h. p. or more, $30. The fee is based on the insurable horse power of the car.

[1] EDITORIAL NOTE: We regret to note that this bond issue carried, as it places the entire burden of construction and maintaining the State system forever on the owners of motor vehicles, and as no part of the cost is to be borne by country or city property.

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For electric automobiles, other than trucks, the tax is $20; for steam automobiles, $25; motorcycles, $5; motorcycles with side seats, $7.50.

Automobiles, commercial.—Trucks less than 1 ton, $15; trucks 1 to 2 tons, $22.50; trucks 2 tons and less than 3 tons, $37.50; 3 tons to 4 tons, $56.25; 4 tons and over, $75. No aggregate load exceeding 10 tons will be allowed on public roads.

Automobiles for hire.—With seating capacity of 5 persons, or less, $37.50; seating 5 to 10, $60; 10 persons or more, $90.

Road Funds

Seventy-seven and one-half per cent of all funds derived from the sale of motor vehicle licenses go to the State highway department. For the fiscal year 1920 this will amount to approximately $600,000. No part of convict fund will hereafter be used by the State highway department.

The appropriation for the last fiscal year, 1919, was $154,000, plus balance unused from the previous year, which in all amounted to $3,092.32 per county. These funds were derived from the net proceeds of the State convict fund. Practically all State work during the past year has been done in conjunction with Federal aid, as the State had only a small appropriation, the major part of all amounts raised to meet the Federal aid being appropriated by the counties.

Progress Report

The combined expenditure of Federal, State and county funds on Federal aid projects during 1918 was $359,654.79. Work completed was 11.52 miles gravel, 85.28 miles sand-clay, and 12.00 miles graded roads, and 158 feet concrete bridges.

Exclusive of State or Federal aid the counties did practically no new work during 1918, owing to war conditions, but spent $992,-108.42 on maintenance.

During 1919 there was available for State aid approximately $350,878.

State Highway Officials

State Highway Commission.—Hon. John Craft, Mobile, Ala.; Mr. F. J. Cramton, Montgomery, Ala.; Senator J. B. Espy, Abbeville, Ala.; Mr. Lloyd M. Hooper, Selma, Ala.; Senator O. T. Smith, Goodwater, Ala.; Senator John A. Rogers, Gainsville, Ala.; Mr. Thomas E. Orr, Albertville, Ala.; Mr. Andrew G. Patterson, Decatur, Ala.; Mr. S. R. Batson, Birmingham, Ala.; Hon. W. C. Davis, Jasper, Ala.; Dr. E. A. Smith, University, Ala.; Prof. C. A. Baughman, Auburn, Ala.

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State highway engineer, W. S. Keller. Headquarters, Montgomery.

Revised by W. S. Keller, State highway engineer.

ALASKA

Road work in Alaska is under the direction of a board of road commissioners, the department of agriculture and the territorial board of road commissioners. The first two agencies have jurisdiction over the Federal work and the territorial board administers the territorial work.

Board of Road Commissioners for Alaska

The board of road commissioners for Alaska was organized May 15, 1905, by order of the Secretary of War, in conformity with an act of Congress approved January 27, 1905. The organization consists of three members, one of whom acts as president of the board, one as engineer officer responsible for the proper execution of all work in the field, and one as disbursing officer in charge of the office and all disbursements. From its inception until December 29, 1917, the board reported direct to the War Department, through the adjutant general, but on the latter date orders were issued by the Secretary of War placing the work under the general supervision of the chief of engineers.

The act of Congress authorized the board, "upon their own motion or upon petition, to locate, lay out, construct and maintain wagon roads and pack trails from any point on the navigable waters of Alaska to any town, mining or other industrial camp or settlement, or between any such town, camps or settlements therein, if in their judgment such roads or trails are needed and will be of permanent value for the development of the district." In accordance with this authority, the board has from time to time undertaken the construction of new roads and trails, with a view to rendering reasonably accessible all parts of the Territory, and aiding in the early development of the productive sections. Unexpected discoveries of mineral deposits in different parts of the Territory and the likelihood of further discsoveries have made the adoption of a fixed project impossible, but practically all of the roads and trails west of the 141st meridian have been laid out so as to form part of a connected system, covering nearly all of the developed portions of the Territory.

The act carried with it a provision for the expenditure of 65 per cent of what is known as the Alaska fund, derived from vocational and trade licenses outside of incorporated towns. This

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fund proved to be so entirely inadequate, as well as so uncertain in amount, that the president of the board at the end of the first season set forth the situation in a special report. The Secretary of War took the matter up with Congress, with the result that an appropriation of $150,000 was made for the fiscal year 1907 in aid of the work.

The amount expended on all projects from January, 1905, to June 30, 1919, was as follows:

Construction	$3,026,878.33
Maintenance	1,893,777.34
Total	$4,920,655.67
Unexpended balance	49,671.21

Of this amount, $2,920,000 was appropriated by Congress and $2,050,326.88 was received from the Alaska fund. During the fiscal year ending June 30, 1919, $184,195.15 was expended for maintenance and $114,829.11 for construction, a total of $299,-024.26.

June 30, 1919, there remained an unexpended balance of $49,671.21 and Congress appropriated $100,000. Receipts from the Alaska fund are estimated to amount of approximately $80,000 during the year, which will make about $230,000 available for road work. In the face of exceedingly high cost of labor and supplies and the greatly increased maintenance expense due to additional mileage, this sum is much below the yearly average since 1905.

The result of the expenditure is a total mileage of roads and trails aggregating 4,830 miles. Of this amount, 2,866 comprise a connected system reaching from Valdez on the coast and Chitina on the Copper River railroad, to Eagle, Fairbanks and several settlements above the Arctic Circle, to the Lower Yukon, Nome, Candle, and Bering Straits. This system is joined at several points on the Yukon River by a secondary connected system of 1,736 miles, which begins at Seward, on the coast, and serves the Iditarod, Ophir and Innoko districts. In addition to this 4,602 miles of connected roads, there are 288 miles of short local roads and trails in various other parts of the Territory.

Practically all of the roads and trails are used as mail routes and by far the greater part of the system furnishes the only means of communication in this vast territory. Of this total, 1,031 miles are classed as wagon road, 636 as winter sled roads, and 3,223 miles of trail. Approximately 400 miles of wagon road has a light gravel surface.

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About 425 automobiles and trucks are used in the Territory. While funds have not permitted the construction of automobile roads, nevertheless 90 per cent of the summer traffic is handled by motors.

The average cost of wagon road to date is approximately $3,750 per mile; sled road, $450 per mile, and trails, $150 per mile.

The headquarters of the commission are located at Juneau. The Territory is divided into five districts. The southeastern district comprises that part of Alaska south and east of the 141st meridian; the Valdez district, the country west of the 141st meridian, running as far north as Richardson on the Valdez-Fairbanks road, and bounded on the west by the 148th meridian; the southwestern district, the territory between the 148th meridian and Kuskokwim River, including the Tacotna and Ophir sections. The Yukon district begins at the north boundary of the Valdez district at Richardson, and includes all work along the Yukon River, the country around Fairbanks, and the Tanana River Valley. The Nome district is confined to the Seward Peninsula.

Each district is in charge of a district superintendent, the superintendents of the Yukon and Nome districts also being bonded disbursing clerks. In the spring of 1918 the Valdez-Chitina-Fairbanks road and all connecting wagon roads were placed under the direction of a district engineer, with headquarters at Valdez. Under each superintendent are foremen in charge of working crews on different projects. The crews are often working far from headquarters and the distances are so great and means of transportation so uncertain and slow that it is difficult for the superintendents to visit all of the projects in their districts. As the principal working season begins in June and ends in October, the superintendent is a busy man and his efforts are necessarily confined to the most important projects.

The members of the board are:

W. H. Waugh, major, engineers, president and engineer officer.
John Zug, captain, engineers, assistant engineer officer.
Sidney L. Carter, 1st lieutenant, engineers, disbursing officer.

Department of Agriculture

Under the provisions of section 8 of the Federal aid road act the system, as planned, embraces a total of 256 miles of roads and trails. On July 1, 1919, $245,451 of Federal funds were available for this work. As the Territorial law did not permit coöperation as required under the terms of the Federal aid act, no construction could be undertaken until the legislature passed a law meeting the requirements. In April, 1919, a law was passed giving

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the Territorial board of road commissioners (composed of the governor of the Territory, surveyor general and Territorial treasurer) authority to enter into cooperative agreements with the board of road commissioners for Alaska and the Secretary of Agriculture. The result of this law will permit the closest coöperation.

The Federal work is centralized, as Major W. H. Waugh, president of the board of road commissioners for Alaska, is also the representative of the Department of Agriculture on all work coming under the provisions of the Federal aid road act. Six projects, aggregating 33 miles and estimated to cost $163,000, are now under construction. Of this amount, $99,000 is from Section 8, F. A. R. act, $43,000 from the Territory and $21,000 from the board of road commissioners for Alaska.

Preliminary investigations have also been made on 20 miles estimated to cost $95,000, and construction of these projects will probably be undertaken next year.

Territorial Board of Road Commissioners

By act of the Territorial legislature, session of 1919, the Territorial board of road commissioners is composed of the governor, surveyor general, and Territorial treasurer, who have general supervision over the Territorial road work.

The Territory is divided into four divisions, which correspond to the four judicial divisions. Four hundred thousand dollars were appropriated for the period of two years, $100,000 being allotted to each division. The road law authorizes the Territorial board to enter into coöperative agreements with the board of road commissioners for Alaska and the Secretary of Agriculture for the construction, repair and maintenance of any public road, bridge or ferry within Alaska. During the present season $50,000 were allotted for cooperative work with the board of road commissioners for Alaska and $43,000 for cooperation jointly with the Department of Agriculture and the board of road commissioners for Alaska, under the provisions of section 8 of the Federal aid road act. There is approximately $35,000 additional tentatively allotted for cooperative work with the board of road commissioners for Alaska. Approximately $200,000 is allotted each year, the remaining $72,000 for 1919 being expended by the chairman of the four divisional road commissions, composed of a chairman elected by popular vote, and two members appointed by the governor. The law provides that after March 1, 1921, the chairman shall be appointed by the governor and two other members of the divisional commission shall be elected by popular vote.

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The Federal Government has consolidated highway matters in Alaska under one head. Offices are maintained at convenient points, and as there is no overhead charge on cooperative work it is quite an advantage to the Territorial officials to do most of their work in cooperation with the Federal authorities.

The members of the Territorial board are:

Thos. Riggs, Jr., governor, chairman of the board.

Robert J. Sommers, surveyor general, secretary of the board.

Walstein G. Smith, Territorial treasurer.

Head offices are at Juneau, Alaska.

Prepared by W. H. Waugh, major of engineers, president board of road commissioners for Alaska.

ARIZONA

State Aid Legislation

The State highway department is administered by the State engineer, who is appointed by the governor for a term of two years. He is assisted in the central office by an office engineer in charge of engineering matters and a chief clerk in charge of accounting, records, etc. Technical and clerical assistants are appointed by the State engineer. A chief of location, four division engineers with necessary resident engineers, chiefs of survey, and location parties attend to the field work of the department.

The State highway department has charge of the construction of all work financed wholly, or in part, with State or Federal funds, and on request acts in an advisory capacity to local officials. A system of State highways comprising 1,600 miles has been laid out by the boards of county supervisors with the approval of the State engineer. These roads are improved under the direction of the highway department with State, Federal and county funds. State highways when completed are maintained by the State.

Federal Aid.—The highway department made application for Federal aid on practically every project undertaken during 1919. The amount of Federal aid available in 1919 exceeded $2,300,000—the amount of State funds—so that the State department cooperated with the county highway commissions in the construction of roads, in order to take advantage of all available Federal funds. All Federal aid is being applied to the State highway system.

Local Legislation

The county boards of supervisors have jurisdiction over local roads. They may appoint a county engineer at a salary not exceeding $3,000 per year.

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Boards of supervisors may levy a regular tax at a rate not exceeding 25 cents on the $100, the proceeds to be expended by the board. The assistance and advice of the State engineer may be requested in the expenditure of this money. A $2.00 poll tax is also levied by counties, and the highway commissions and boards of trustees for districts may levy special taxes for road purposes within their jurisdiction.

Bond Legislation

Bonds may be issued by the county boards of supervisors when authorized by a majority vote of the property tax paying voters, when a county highway commission has been legally constituted. These commissions consist of five members appointed by the board of supervisors to have charge of the expenditure of funds derived from the sale of bonds. Such commissions may appoint an engineer and other assistants to take charge of road work. The bonds must be of the serial type, bearing not to exceed 6 per cent interest and may not run longer than 40 years.

Sinking fund bonds bearing not to exceed 6 per cent interest, when authorized by two-thirds majority of the property tax paying voters affected, may be issued by the trustees of legally constituted special road districts.

Convict Labor Laws

State convicts may be used on State highways and bridge construction under the prison law, which provides $60,000 annually for meeting the cost of such labor. In addition, the prison maintenance fund pays into the State road fund an amount equal to the expense of keeping the number of prisoners employed on the State highways and bridges.

Automobile Registration

The Secretary of State has charge of registration, the rate being $5 for 25 h. p. and less; 25 to 40 h. p., $10; over 40 h. p., $15. The rate for motorcycles is $2.

State Road Funds

A tax of one mill on each dollar of the assessed valuation is levied annually within the State for the purpose of raising a fund to be known as the State road fund for use in the construction and maintenance of State highways and bridges. This fund produces approximately $900,000 per annum. Twenty-five per cent

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of this money is expended upon the authority and under the direction of the State board of directors and the State engineer. Seventy-five per cent of the fund must be spent in the respective counties in which it is raised upon the authority and under the direction of the county board of supervisors and the State engineer. The receipts from automobile licenses go into what is known as the 25 per cent State road fund. They produce about $164,000 per annum.

Special appropriations were made by the legislature of 1919 as follows: For a bridge over the Colorado River in Mohave County, conditioned on a like appropriation by Mohave County, $40,000; for approaches to Lee's Ferry across the Colorado River in Coconino County, $10,000; to assist in financing Federal aid projects, $200,000; to aid in the construction of a road from Superior to Miami, $100,000; for a road from Williams to Clarkdale, $25,000; for a bridge across the Gila River near San Carlos, $65,000; for constructing the Arizona section of the Arrowhead Trail, $50,000; for a bridge across Oak Creek, $10,000; for a bridge across the Colorado River near Parker, $30,000.

The individual appropriations, the receipts from the State tax and the automobile fund will give the State approximately $1,594,000 to be expended during the fiscal year ending June 30, 1920.

Progress Report

State and county funds combined with Federal aid will be sufficient to complete highways from the New Mexico line through Douglas, Bisbee, Tombstone, Benson, Tucson and Florence to Phoenix, and from Franklin through Clifton, Safford, Globe, Miamaih and Superior to Phoenix, and a greater part of the highway from Phoenix to Yuma within the fiscal years ending June 30, 1920, and June 30, 1921.

County bond issues for highway construction have been authorized as follows: Maricopa County, $4,000,000; Pima, $1,500,000; Pinal, $1,000,000. Bond issues are contemplated in Yavapai, Coconino, Graham, and Yuma counties. No county bond issues have failed to pass.

State Highway Officials

Thos. Maddock, State engineer.
Doane Merrill, chief clerk.
F. N. Holmquist, office engineer.
Revised by F. N. Holmquist, office engineer.

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ARKANSAS

State Highway Legislation

An act approved March 31, 1913, changed the State land office into a department of State lands, highways and improvements, and created in connection with it a highway commission and a highway improvement fund. The State highway commission consists of three members, made up of the commissioner of State lands, highways and improvements, chairman; and two members appointed by the governor, who serve two years, the term of one member expiring each year.

There is an advisory board to the highway department, composed of the State highway engineer, the head professor of civil engineering of the University of Arkansas, who is ex-officio consulting engineer of the highway department, and a member appointed by the governor.

The commissioner of State lands, highways, and improvements appoints a State highway engineer subject to the approval of the commission. The engineer must be a graduate in engineering of some reputable school of engineering and skilled in road building. He holds office for the term of two years.

The highway improvement fund is derived from motor vehicle fees and licenses. This fund is used for the support of the highway department and, together with Federal aid, is apportioned to counties or projects by the State highway commission on approval of the advisory board.

The department is required to collect data, to see that road laws are enforced, and to hold road institutes at least once a year, which county judges, county engineers and road overseers are required to attend, and for which they receive the same pay as if they were engaged in actual work. The department is required to furnish plans and specifications when requested to do so, and to aid in the formation and management of highway improvement districts. The department is authorized to determine the method of distribution of any State and Federal road funds that may be available.

Highway improvement districts are created on application to the county courts, giving description of the roads to be improved and the territory traversed by them.

Federal Cooperation.—Under an act approved in March, 1917, the State highway department is given authority to take advantage of Federal aid and to cooperate with the Federal Government. The State's share of the funds are derived from the highway improvement fund appropriated by the legislature and from the

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funds of the various road improvement districts to which the aid is granted.

The State commission allots State and Federal aid funds to the various road improvement districts upon recommendation of the advisory board.

Local Legislation

The county judge has original exclusive jurisdiction over the county roads. Overseers and commissioners of county and township roads are either elected or appointed, depending upon the law affecting each county.

The per capita road tax may be worked out. A 3-mill road tax on all assessed property is collected in cash. Special assessment districts for road construction may be formed upon petition of a majority of the property owners. The cost is assessed upon the property and the work done under the supervision of three commissioners, who receive not more than $5 per day each for the time actually employed.

Bond Legislation

An act approved March 30, 1915, provides for the formation of road improvement districts and for floating bonds (the life of which are not to exceed 30 years) for the purpose of building, constructing and maintaining highways. The board of commissioners of a road improvement district may issue bonds to be retired either serially or by a sinking fund. Under this act the highway department is required to make preliminary surveys, plans, specifications and estimates of cost when petitioned by 10 or more land owners or the county judge for the purpose of organizing a road improvement district.

Convict Labor

The highway commission may employ as many of the State convicts on the public roads as may not be otherwise employed by the penitentiary authorities, the expenses to be borne by the county or improvement district in which they work.

County convicts may be worked upon the highways of a county. Special road improvement districts may use convict labor and pay a flat rate of 75 cents per day to the county.

Automobile Registration

Automobiles are registered annually with the commissioner of State lands, highways and improvements, through the county tax collector, whose receipt is forwarded with the application for

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registration. The fees are as follows: All motor vehicles, $10; dealers, 1 car in each class (electric, gas or steam), at regular rate; chauffeur's license, $1.

The revenues are paid in and credited to the State highway improvement fund. The fees and forfeitures are paid into the general school fund of the county in which they are imposed.

Road Funds

Approximate State funds derived from motor vehicle registration available for 1919-1920:

For State aid	$950,000
Annual 3-mill county road tax estimated	1,500,000
Federal aid, 1917–1921	4,615,210
Road improvement district funds from sale of bonds, estimates for 1919–1920	40,000,000

State Highway Officials

Wm. B. Owen, chairman; R. R. Thompson, member; J. S. Turner, member; T. P. Murray, secretary; V. P. Knott, State highway engineer; J. W. House, Jr., attorney. Headquarters, Little Rock.

Approved by V. P. Knott, State highway engineer.

CALIFORNIA

State Aid Legislation

State road work is under the general direction of the advisory board of the State department of engineering, consisting of the governor, who is ex-officio chairman; the State engineer; the general superintendent of State hospitals; the chairman of the State board of harbor commissioners of San Francisco, and three members appointed by the governor. It is directly administered by the three appointed members, who are constituted a subdivision of the State department of engineering, designated by statutory enactment as the California highway commission. The highway engineer, appointed by the governor, is the executive officer of the commission, and in his charge is placed the construction of the State highway system.

The people of California have adopted three State highway bond issue propositions involving $73,000,000, the first known and cited as "State Highway Act," in amount $18,000,000, at the general election of 1910; the second, "State Highway Act of 1915," in amount $15,000,000, at the general election of 1916; and the third,

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in the form of an amendment to the State constitution, in amount $40,000,000, at a special election held July 1, 1919.

The State highways, in the language of the first bond act, are to be acquired and constructed through the Sacramento and San Joaquin valleys and along the Pacific Coast, and connecting county seats lying east and west of the main routes. The second bond act added eight specific extensions to the original system. The third bond measure provides for the completion of the original system, the eight extensions provided by the act of 1915, and 30 additional road projects particularly described in the new bond proposition of 1919.

The entire system is to be constructed and maintained at the expense of the State, except that each county must pay into the State treasury 4 per cent under the first bond issue and 4½ per cent under the second and third issues upon the amount expended in the county in the construction of State highways, less such portion as the bonds matured shall bear to the total number sold and outstanding. The cost of maintenance is provided for through funds derived from the State license fee imposed upon motor vehicles.

The State department of engineering has general authority over all participation by the State in works of highway improvement, and is given authority, acting through the California highway commission, to make investigations regarding highway betterment or extension which may be deemed desirable. In addition to the system of State highways, provided by the bond issues, appropriations have been made from time to time by the State legislature for construction of roads of State importance, particularly in mountainous sections and in localities where the sparse population makes the expense an undue legal tax burden.

Federal Cooperation.—Under the Federal aid act there is allotted to California a total sum of approximately $8,378,000, of which $2,434,000 is available to and including the fiscal year 1919, $2,896,000 for the fiscal year 1920, and $3,048,000 for the fiscal year 1921.

Local Legislation

County supervisors, of whom there are five in each county, elected for a term of four years in November for even years, have authority over roads. The county surveyor is elected.

The board of supervisors at their option may appoint, or upon a petition therefor signed by at least 25 per cent of the voters of the county must appoint a competent civil engineer, who has had within the last five years not less than one year's actual experience in practical road building, as county engineer. The county

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engineer, under the general direction and supervision of the supervisors, and except as otherwise provided by law, has complete direction and control over all of the construction, improvement, maintenance and repair of county roads, highways and bridges.

County revenues for road improvement are derived principally from a tax on property at rates not to exceed 40 cents on each $100 and from one-half of the net automobile revenues.

Local Bond Legislation

Upon petition of 10 per cent of the freeholder electors of any county, praying that the issuance of bonds for highway purposes be submitted to the electors, the county supervisors may appoint a highway commission of three members to investigate the main roads and report to the board those roads that should be improved, their estimated cost and the amount of bonds to be issued. If this report is approved by the board, an election on the issuance of the bonds must immediately be called. A two-thirds affirmative vote of the qualified electors is required. The term and rate of interest is not specified in the act. All work done with the proceeds of the bond issue shall be under the direction of the highway commission.

The county supervisors of any county may create road districts, under two different acts. A permanent road district (act of March 19, 1907,) may be created upon the petition of a majority of the land owners of the proposed district, who may, in their petition, propose a bond issue for certain road improvements. This proposition must be submitted by the supervisors to the electors of the district, and if two-thirds of the votes cast are favorable, bonds of the district shall be issued not to exceed 15 per cent of the assessed valuation, to run not to exceed 20 years, at not to exceed 7 per cent per annum.

A special road district (act of March 21, 1907) for certain specified improvements on established roads may be created by the county supervisors after giving notice of the proposal, if a majority of the land owners of the proposed district do not file objections prior to the date set for hearing objections. Upon the creation of the district contracts under the approved specifications shall be awarded to the lowest responsible bidder and, upon the completion and acceptance of the work, bonds of the district shall be issued to pay for this work, to run not to exceed 20 years, and bear interest not to exceed 7 per cent.

Under both acts a tax must be levied to pay interest and principal when due, although in the case of bonds issued by a special

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road district the county supervisors may make transfers of funds for the payment of interest and principal when due.

Convict Labor Law

An act authorizing the use of convict labor on State highways was passed in 1915. Upon the requisition of the department of engineering, the State board of prison directors shall send to the place, and at the time designated, the number of convicts requisitioned, or such portion thereof as are available in the judgment of the warden. The department of engineering designates and supervises the work done and provides and maintains necessary camps and commissariats. The State board of prison directors has full jurisdiction over the discipline and control of the convicts employed. The convicts are compensated by a reduction of their time to serve in prison, not to exceed one day for each two calendar days that the convict is absent from the prison.

Automobile Registration

Annual registration is required, the application to be forwarded to the motor vehicle department with fee, which issues number plates, etc., and makes record. Registration fees are as follows:

For every automobile, except electric automobiles, 40 cents for each h. p. or major fraction thereof; motor vehicles equipped with other than pneumatic tires and used for commercial purposes, according to weights, a graduated fee, in addition to the regular fees; electric motor vehicles, $5; motorcycles, $2; dealers, for each 5 cars operated, $25, and $2 for every automobile in excess of 5 so operated, including the necessary number of plates; motorcycle dealers, $5; chauffeur's license, $2.

Road Funds

The maintenance of the State and certain county roads is taken care of by the fund collected from the license tax on motor vehicles. After deducting the cost of licenses and collection, half the money is used for the maintenance of State highways and the other half divided among the counties of the State in proportion to the amount collected from each county for licenses, this amount to be used in the maintenance of county highways. In 1918 approximately $3,600,102.62 was collected. Funds for the construction of State highways are derived from State bond

Progress Report

The State highway work has been in progress since the spring of 1912. On August 1, 1919, the system included 1,853 miles of

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completed highway of the following types: Concrete base with asphalt surfacing, 40 miles; macadam base with asphalt surfacing, 16 miles; concrete base with thin bituminous surfacing (all surfacing not yet placed), 1,163 miles; oiled macadam roads, 212 miles; bituminous pavement, 16 miles; graded roads otherwise unimproved, 406 miles; unfinished roads with concrete base, 208 miles; unfinished graded roads otherwise unimproved, 249 miles.

State Highway Officials

State Highway Commission, Sacramento.—Newell D. Darlington, Los Angeles, chairman; Chas. A. Whitmore, Visalia; George C. Mansfield, Oroville. Austin B. Fletcher is the highway engineer and executive officer of the commission and Wilson R. Ellis of Berkeley is the secretary. Division offices are maintained in San Francisco, Los Angeles, Dunsmuir, Fresno, San Luis Obispo and Willits.

Prepared by A. B. Fletcher, State highway engineer.

COLORADO

State Aid Legislation

The State highway department consists of a highway commissioner appointed by the governor for a term of four years, a board of five members with terms of five years, the term of one member expiring each year, a secretary and other assistants employed by the commission. The commission is required to prepare a map showing the public roads in each county connecting the roads of sufficient importance to receive State aid and form a connecting system of State routes. A system of about 8,000 miles of State routes has been laid out, from which the commission selects the roads which are to be improved through Federal aid and in coöperation with the several counties, these roads being referred to as State routes.

The commission is given authority to apportion the State aid road fund among the counties, taking into consideration area, amount of money expended in construction, difficulty and extent of such construction, and extraordinary expenses in connection with the development of new territory. Counties receiving such aid are required to raise an amount equal to the amount set aside by the State unless the State highway commission should desire to extend further aid to poorer counties, in which case it may extend aid in various proportions from 1 to 1 to State all. The county commissioners coöperate with the State in selecting from

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the State routes the roads on which the combined State, county or Federal money is to be expended.

Surveys, plans and specifications are made by the county commissioners and submitted to the State highway commissioner for approval. Contracts are let by the county commissioners after approval by the State highway commissioner, or directly by the State highway commission. The State commission does all the engineering work on Federal aid projects, while construction and maintenance are under the supervision of the county commissioners, subject to the approval of the State highway commissioner.

Federal Aid.—The Federal aid program in 1919–20 in Colorado includes 117 projects. These have a total mileage of 882, and total cost estimates of $5,425,000, 50 per cent of which will be required from State funds, which will absorb every available dollar. There are approximately 8,000 miles of State highways, and deducting the mileage to be improved under Federal aid, there will remain 7,117 miles of State roads without financial provision for construction or proper maintenance.

Local Legislation

In each county a board of three county commissioners serving four-year terms has jurisdiction over local roads. They may appoint a general overseer for all such roads or divide the county into districts and appoint a district overseer for each.

Bond Legislation

The legislature of 1919 authorized a $5,000,000 bond issue to be approved by a popular vote in 1920. One-half of the proceeds of this issue is for the purpose of meeting Federal aid and the construction of post roads, and one-half of it is for State aid to counties.

When the county commissioners of any county shall deem it necessary to create a county indebtedness for road and bridge purposes, they may submit the proposition to a vote and, if a majority of the votes cast are in favor of the proposition, they may issue bonds of the county in the aggregate not to exceed the following: Counties of assessed valuation less than $5,000,000, $12 on each $1,000; and counties of assessed valuation over $5,000,000, $6 on each $1,000. These bonds shall bear interest not exceeding 10 per cent per annum, and shall be payable at the pleasure of the county after 10 years, but absolutely due and payable 20 years from the date of issue. An annual tax must be levied by the commissioners to pay the interest on the bonds,

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and for their ultimate redemption. The commissioners must levy annually, after 10 years, such a tax upon all taxable property in the county as will create a yearly fund equal to 10 per cent of the whole amount of the bonds.

Convict Labor Laws

At the request of the board of county commissioners the warden of the State penitentiary shall detail such a number of prisoners to work on public roads as he shall deem proper. The additional cost of guarding and other expenses must be borne by the county.

Automobile Registration

Motor vehicles are registered annually with the Secretary of State. The fee for passenger cars is one-half of 1 per cent of the original cost price to owners, f. o. b. factory, with a minimum fee of $5. A reduction of 50 per cent on this rate is allowed for cars purchased 8 years previous to registration and a reduction of 30 per cent is allowed for cars purchased 5 years previous to the date of registration.

Registration fees for motor trucks are: 1 ton and less, $10; 1 to 2 tons, $17.50; 2 to 3 tons, $25; 3 to 4 tons, $37.50; 4 to 5 tons, $50; for each additional ton or fraction thereof over 5 tons, $25; for motor vehicles used in transportation of passengers for hire and which seat nine passengers, $20, with an additional fee of $1 for each additional seating capacity provided.

Road Funds

State road funds are obtained from the following sources: 1. Proceeds from a one-half mill State-wide tax levied on all taxable property in the State, which annually amounts to approximately $700,000; 2. Receipts from an internal improvement fund, about $150,000; 3. One-half of the revenue derived from the registration of automobiles, about $300,000. The automobile revenues are divided equally between the State road fund to be expended in improving and maintaining State roads and the road fund of the counties according to the collections from each county. Fines and forfeitures are divided equally between the State and county road funds.

In addition to the State road money, the counties levy a tax for local road purposes which averaged in 1919, 2.747 mills and produced $2,625,834.

Progress Report

No roads have been completed entirely at the expense of the State. It is estimated that about 6,000 miles have been improved

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partly at the expense of the State and partly at the expense of local subdivisions. An additional 600 miles are in course of improvement jointly by the State and subdivisions. No roads are maintained at the expense of the State, but there are approximately 7,800 miles maintained under the direction of the county commissioners, for which the State pays a portion of the cost. There were 2,100 miles of road graded and drained and about 310 miles surfaced with gravel, shale sand and clay under the direction of the State highway commission during the year 1918.

The total expenditure of State funds on State roads in 1918 was $850,000 and of county funds on these roads approximately $500,000, making a total expenditure on the State road system for the year of approximately $1,350,000.

State Highway Officials

State Highway Commissioner, T. J. Ehrhart; Chief Engineer, J. E. Maloney; State Highway Commission, Elmer E. Sommers, Chairman, District 1, Denver; E. E. Nichols, District 2, Manitou; Fred J. Radford, District 3, Trinidad; T. J. Goble, District 4, vice-chairman, Silverton; R. E. Norvel, District 5, Hayden. Headquarters, Denver.

CONNECTICUT

State Aid Legislation

The State highway commissioner, who shall be a capable road builder, is appointed by the governor with the consent of the Senate and holds office for four years. He is empowered to enter any town in the State and to lay out and improve any of the legally established trunk line roads and certify the cost to the State comptroller for payment, providing such payments do not exceed appropriations made for the purpose by the legislature. He has authority to approve the application of the selectmen of any town for State aid, to select the highway to be improved with such aid, to make surveys, plans and specifications therefor, to determine the character of the work, and to supervise the construction. He may reject any and all bids for highway construction, and where the cost is less than $1,000 he may at his discretion permit the town to do the work. He must keep all State roads in repair and certify the cost to the comptroller. He is authorized to appoint a deputy commissioner, division engineers and such other assistants as he may deem necessary and fix their salaries.

Whenever any town desires to improve a public or State aid

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road with the aid of the State the selectmen of the town make application to the State highway commissioner for such aid, and the application is subject to his approval. The aid granted by the State is apportioned as follows: In towns having a taxable valuation of over $1,250,000 the State pays three-fourths of the cost of roads constructed as State aid roads, and in towns having a valuation of $1,250,000 or less the State pays seven-eighths of the cost of construction.

A trunk line system comprising the principal roads of the State, embracing 1,500 miles, is gradually being constructed and maintained entirely at the cost of the State. Of this system 1,050 miles have been improved. The State highway commissioner is authorized to lay out, widen and grade any highway in the State whenever he deems it necessary for the purpose of connecting with the trunk line highways. Towns are permitted to improve State aid roads with their own funds and to cover their proportion of the cost of the improvement under a subsequent appropriation by the State. The work must be done under the supervision of the State highway department and must not exceed an amount designated by the department.

The maintenance of trunk line roads is paid for entirely by the State, while the maintenance of State roads other than those on the trunk lines is borne by the State and town in the ratio of three-fourths and one-fourth, respectively. All moneys received by the State from automobile licenses and fines are applied to road maintenance.

The law of 1915 directs the highway commissioner to erect and maintain uniform direction and danger signs on trunk line highways. It also provides that the highway commissioner may petition the public utilities commission for authority to eliminate dangerous conditions on these highways. This is a distinct departure from the previous policy of the State.

A law which placed under the jurisdiction of the highway department all trunk line highway bridges having a span greater than 25 feet, whether these bridges are located on improved sections of road or not, was passed in 1915 and amended in 1919 to include bridges on State aid roads. When bridges are between two towns or two counties, the State pays half of the cost and the two towns or counties the other half. When any lines of an electric street railway company cross such a bridge, the expense is divided one-third by the State, one-third by the railway company and one-third by the town or towns.

The 1915 law makes the State responsible for damages to persons and property when caused by an imperfect condition of a State highway due to carelessness or neglect. Before the passage

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of this law the State could not be sued, and as the maintenance of trunk line highways was removed from the towns anyone injured in person or property had no recourse at law. The 1915 law imposed upon the State highway department the obligation to keep trunk line highways sufficiently free from snow during the winter season to allow travel over them. The expense is borne by the State.

A law of 1917 provides for the State's participation in money allotted by the Federal government for the improvement of State trunk line highways. Under this law one section of concrete road already has been constructed and two contracts recently have been awarded for other work.

Local Legislation

Local road work is under the board of selectmen of each town, selected annually. If they refuse or neglect to maintain the roads, the board of county commissioners may order the work done, when petitioned to do so. Funds for town roads are usually paid from the town budget tax. The State highway department has no authority for town roads.

Bond Legislation

No local bonds are issued, but from time to time the State has issued bonds for roads and other purposes. In 1907 and again in 1911, when deficits occurred in the State treasury, a total of $7,000,000 of State bonds was issued. The larger portion of the receipts was appropriated to pay the State's portion of State aid and trunk line roads.

Automobile Registration

Annual registration with the motor vehicle commissioner is required. Registration fees are as follows: Automobile, 50 cents per h. p.; motor trucks, 1,000 lbs. or less capacity, $11; 1 ton, $15; 1½ tons, $20; 2 tons, $25; 2½ tons, $30; 3 tons, $35; 3½ tons, $45; 4 tons, $55; 4½ tons, $65; 5 tons, $75; 5½ tons, $87.50; 6 tons, $100; 6½ tons, $112.50; 7 tons, $125; 7½ tons, $150; 8 tons, $200; for each additional ton above 8 tons, $100.

Motorcycles, $2; public service motor vehicles, 5 passengers or less, $15; for each additional seat up to 20, $2 per seat; for each additional seat up to 40, $5; for each additional seat over 40, $10.

Dealers and repairers, $10 for each pair of plates up to 12 pairs, minimum fee of $50; gasoline license, $2 per annum; operator's license, $2 plus $2 for examination of applicant; public service operator's license, $5; examination of public service motor vehicle, $2; transfer fees, motorcycle, 50 cents; motor vehicle,

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$1; passenger to commercial car or commercial car to passenger car, $2; copies of registration or license certificate, 50 cents; replacement of lost number, $1.

If registered as pleasure and commercial, the fee will be $2 in addition to the above fees.

Road Funds

The legislature of 1919 changed the fiscal year so that it would end on June 30 instead of September 30, as heretofore.

The gross expenditures for the highway department for nine months previous to June 30, 1919, was $2,385,933.80. The purposes to which these funds were applied and the amounts expended for the various purposes are as follows: State aid construction, $67,030.55; trunk line construction, $340,869.84; trunk line bridges, $121,250.91; toll bridges, $19,313.78; trunk line repairs, $1,238,586.64; State aid repairs, $198,604.08; dangerous trunk lines, $1,780.33; Federal aid, $26,070.57; Thames River bridge, $282,984.76; office and clerical, $14,313.67; deputies and engineers, $70,235.19; commissioner's salary, $3,749.94; commissioner's traveling, $387.85; auto, $755.69.

The revenues from the automobile registration licenses, etc., for the nine months' term amounted to $1,361,898.44, all of which was transferred to the State highway department for the repair, maintenance and reconstruction of trunk line highways.

Appropriations for the two fiscal years ending June 30, 1921, are: Special State aid construction, $600,000; State aid construction, $1,000,000; trunk line construction, $2,000,000; trunk line and State aid bridges and ferries, $525,000; trunk line repairs and reconstruction, $2,000,000; elimination of dangerous conditions, $75,000; State aid repairs, $400,000; office and clerical expenses, $35,000; deputies and inspection, $250,000; commissioner's salary, $16,000; commissioner's traveling expenses, $2,000; auto expenses, maintaining and renewal, $6,000; receipts from automobile registration fees, $2,000,000 for the two years for maintenance.

Progress Report

Since February 26, 1913, the date when the present commissioner assumed the position, many important construction jobs have been carried on by the department, among which should be listed the following: Concrete bridge between the cities of Derby and Shelton, approximate cost, $270,000; concrete road under Federal aid project in the towns of Cheshire and Hamden, approximately 6 miles in length, cost, $126,000; the elimination of a dangerous underpass at Windsor, approximately $98,000; the

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elimination of a dangerous grade crossing at Bolton, approximate cost, $57,000; completion of a trunk line highway between Litchfield and New Milford, approximate cost, $164,000; completion of a new section of concrete road in the town of Berlin which eliminated several bad corners, approximate cost, $70,000.

Recently the following contracts have been awarded: Two sections of Federal aid work, the first in the towns of Preston, Ledyard, Stonington and North Stonington, approximately 10 miles in length, the estimated cost of which is $355,000; the other, in the towns of Bethel, Redding and Easton, to cost approximately $315,000 and approximately 12 miles long.

Construction of new concrete bridges across the Housatonic River between Milford and Stratford, estimated cost over $1,000,000.

Conversion of the Thames River railroad bridge into a highway bridge. This bridge spans the Thames River between New London and the town of Groton. The estimated cost of the work is $450,000.

Completion of the east side trunk line highway in the towns of Bethany and Woodbridge to give a connecting road from New Haven into the Naugatuck Valley, approximate cost, $142,000.

Completion of a concrete road in the towns of Enfield and East Windsor, making a hard pavement from East Hartford to the Massachusetts line on the east side of the Connecticut River, approximate cost, $50,000.

In addition to the above work, contracts are also running for the completion of the trunk line highway known as No. 12, beginning at the Massachusetts line at North Canaan and extending through Salisbury and Sharon. The cost of these contracts when completed will be approximately $217,000.

The State has a well organized system of patrolling the improved highways. This is under the direct charge of a superintendent of repairs. The actual work is carried on by 11 supervisors, 660 laborers, 118 trucks and 116 teams. The State also has a complete equipment of road rollers, scrapers, hones and other machinery of a kindred nature.

State Highway Officials

Chas. J. Bennett, highway comissioner.
Richard L. Samons, deputy.
W. L. Ulrich, superintendent of repairs.
C. G. Nichols, chief clerk.
Revised by C. G. Nichols, chief clerk.

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DELAWARE

State Aid Legislation

The first State-aid law was enacted in 1903. It provided money aid to the amount of $10,000 per annum for each of the three counties, to be expended with an equal amount raised by the counties under a State highway commissioner for each county.

From 1903 to 1917 about 180 miles of more or less disconnected road were constructed under the State-aid system. In addition to the money appropriated for each county, $1,000 was appropriated by the general assembly to pay the salary of the State highway commissioner for New Castle county, the State-aid money in the other two counties being expended under the direction of the county engineers.

The legislature of 1917 created a State highway department and provided for the construction and maintenance of a system of State highways entirely at the expense of the State. This system is to include 650 miles and is to be paid for from the funds derived from the State bond issue, proceeds from the automobile licenses, and the State income tax.

The State highway commission is composed of the governor and four members appointed by the governor, who serve without compensation, and not more than two members belonging to the same political party. One member must be a resident of Wilmington and one from each of the three counties. The administrative head of the department is the chief engineer, appointed by the commission. He must be a civil engineer, not less than 30 years of age, shall have been in active service of his profession for 10 years, and shall have had responsible charge of engineering work for at least 5 years and shall be qualified to design and direct work. He may receive a salary of $7,500 per annum.

New Castle county still retains the office of the State highway commissioner who has charge of the construction of permanent roads, constructed by county funds as well as the roads constructed with money available from the 1903 State Aid Law. The State highway department has taken up its entire available allotment of Federal aid.

Local Road Legislation

Jurisdiction over local roads is vested in the county courts called the levy courts, which appoint the county road engineers. In Sussex county there is also a bond issue commission which has jurisdiction over the spending of $1,000,000 of road bonds.

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Bond Legislation

The State may issue 40-year, 4½ per cent bonds, subject to call after the first year. The State treasurer is authorized to create a sinking fund and to deposit in it 2½ per cent per annum of the total bonds outstanding.

Up to this time most of the funds with which the roads have been permanently improved in the various counties have been derived from county bond issues. Kent county issued $30,000 in 1913 and New Castle $1,250,000. The general assembly of 1917 authorized $100,000 for Kent county, $600,000 for New Castle, and $1,000,000 for Sussex.

In New Castle and Sussex the bonds may bear 4½ per cent interest, in Kent 5 per cent. They are of the deferred serial type, the first payment falling due 10 years from the date of issue, and the last payment from 39 to 49 years. They may be issued, however, subject to call after 5 years.

Convict Labor

In the counties of Kent and Sussex vagrants and minor criminals may be sentenced to hard labor on county roads. In New Castle county the levy court is empowered to employ all able-bodied convicts on public roads.

Automobile Registration

Automobiles are registered with the Secretary of State. The fee for registration is $2 for each 500 pounds or fraction thereof.

Road Funds

From the automobile fund there is first deducted sufficient money to pay the expenses of the highway department and for the maintenance of State roads. The remainder may be used for the establishment of a sinking fund and for the payment of interest for any State highway bonds which may be issued.

In addition to this revenue, all money above $250,000 received from the State income tax may be used for the construction of State roads. Funds for State-aid roads may be taken from bond-issue funds when issued, the State and the counties each contributing 50 per cent.

The receipts from automobile registrations now available make it possible to raise by bond issue an amount of approximately $3,500,000. In addition to this there is also available for road construction private funds donated by Mr. T. Coleman DuPont to the amount of $2,500,000.

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Progress Report

During 1918 only a small amount of road work was completed by the State highway department, on account of delays occasioned by war activities. During 1919 considerable work has been completed, and there is now under construction approximately 150 miles of road. Contracts are being let continually, and it is expected that the entire North and South system will be completed by the fall of 1920. Much work is also under way on the East and West system.

State Highway Officials

State Highway Department.—Governor John G. Townsend, Jr., chairman; Joseph E. Holland, Walter O. Hoffecker, Josiah Marvel, T. Coleman DuPont; Charles M. Upham, chief engineer; George W. Francis, secretary.

County Officials.—Charles E. Grubb, county engineer and State highway commissioner for New Castle county; Marvel F. Goodden, county engineer for Kent county; W. E. Hawkins, county engineer for Sussex county.

DISTRICT OF COLUMBIA

Control of Roads

The three Commissioners appointed by the President to administer the affairs of the District of Columbia annually forward to Congress through the Secretary of the Treasury estimates of proposed expenditures for each fiscal year ending June 30. As the National Government owns fully one-half the property valuation of the District, Congress appropriates 50 per cent of approved estimates and a like proportion is paid from the revenues accruing from District taxation. Road and street affairs are administered by one of the Commissioners, who is an army engineer.

Automobile Registration

Motor vehicles are annually registered with the collector of taxes, the rates being as follows: 24 h.p. or less, $3; 24 to 30 h.p., $5; more than 30 h.p., $10; motorcycles, $2. This is in addition to the regular property tax.

Progress Report

The mileage of streets and roads in the District of Columbia on June 30, 1915, June 30, 1916, and June 30, 1919, was:

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	1915 Miles	1916 Miles	1919 Miles
Asphalt	154.54	159.42	167.78
Asphalt block	30.17	30.59	21.75
Granite block	25.24	23.93	22.03
Cobble	3.98	3.31	3.01
Vitrified block	1.34	1.34	1.04
Bituminous concrete	7.26	7.26	7.26
Cement concrete	3.00	3.75	6.71
Bituminous macadam	4.35	4.36	123.76
Waterbound macadam	118.98	118.42	.....
Gravel and dirt roads	161.42	161.31	153.49
Durax block	.....	.....	.30
Total	510.19	513.69	517.13

Highway Officials

Engineer Commissioner in charge of public work, Col. C. W. Kutz, U. S. A.; assistant to the engineer Commissioner, in charge of surface division, Capt. F. S. Besson, U. S. A.; engineer of highways, C. B. Hunt.

Road Funds

The following amounts have been appropriated for road and street work in the District of Columbia for the fiscal year ending June 30, 1920: Street improvements, $454,300; repairs to streets, avenues and alleys, $500,000; repairs to suburban roads, $200,000; total, $1,154,300.

Revised by C. W. Kutz, Lt. Col. Corps of Engineers, U. S. A., Engineer Commissioner, D. C.

FLORIDA

State Aid Legislation

The State road commission, created by the legislature of 1915, consists of five members, one representing the State at large and one from each of the four congressional districts. They are appointed for terms of four years.

By the law of 1919, the chairman is the executive officer of the commission and receives a salary of $4,200 per annum. The other members are paid $600 per annum each. The commission employs a secretary at a salary of not more than $2,000 per annum.

The department is authorized to employ a State highway

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engineer who is required to be a competent and efficient engineer well versed in road building. The title "State highway engineer" succeeds that of "State road commissioner" provided for in the original law creating the department. Necessary assistant engineers may be employed.

The department is authorized to enter into contracts and to make such rules and regulations as may be necessary for the construction and maintenance of such roads and bridges as may be by law or by resolution of any board of country commissioners or board of bond trustees of any county or subdivision of any county placed under its supervision and control. The department may have work done by contract or by convict or free labor and may purchase such equipment and supplies as may be necessary.

The department is required to give advice and assistance to boards of county commissioners without expense to the county other than actual expenses of the engineers assigned.

The department is authorized to designate certain roads as State roads and other roads as State-aid roads. State roads are to be constructed and maintained with State funds or with State and Federal funds. When such roads are so designated, they become State property and the State is given the right to acquire the rights of way by purchase or condemnation. State-aid roads are to be constructed with Federal and State or county funds under the supervision and control of the State road department. The counties pay not less than one-half of the cost of construction and maintenance, the balance being paid by the State.

Federal Co-operation: The legislature of 1919 assented to the provisions of the Federal Aid Act and levied a special State-wide tax of 2 mills for 1919 and 1920, with which to raise funds to meet Federal Aid. This fund will not be sufficient to equal the Federal money. The balance is to be raised by the counties, if all Federal funds are to be taken up.

For the protection of hard surfaced roads, which are defined as roads surfaced with brick, concrete, asphalt, sand-clay and sand-bituminous, the legislature of 1919 passed a law limiting loads over them as follows: 200 pounds per wheel, for vehicles having tires 1 inch in width; 500 pounds per wheel for vehicles having 2-inch tires; 800 pounds per wheel for vehicles having 3-inch tires; 1200 pounds per wheel for those having 4-inch tires, and 1500 pounds per wheel for those having 5-inch tires. For any vehicle carrying more than 6,000 pounds an extra inch of tire per wheel for each additional 2,000 pounds or fraction thereof must be provided.

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Local Legislation

Jurisdiction over local roads is vested in boards of county commissioners, five of whom are elected for each county, one for each district. These commissioners appoint three road trustees annually for each road district under whose direction road work is carried on. Special road and bridge districts may be created by election, but special taxes are levied and collected by the county boards. When the electors vote to make their road districts special taxing districts they elect at the same time three trustees to supervise the work. County road taxes may be levied by boards of commissioners at rates of not less than 3 nor more than 8 mills on the dollar. Fifty per cent of such taxes collected in cities and towns must be turned over to municipal authorities for street improvements. Local road taxes may be worked out.

Bond Legislation

Upon petition of 25 per cent or more of the registered voters or freeholders residing in any territory embraced wholly or in part in one or more road districts of a county, requesting that a special road and bridge district for the purpose of improving roads and bridges be created, and that a special tax or that bonds be issued, the boards of county commissioners are required to order an election thereon. If agreed to by a majority vote, the board of county commissioners is required to issue the necessary bonds and levy an annual tax on the district to pay the interest and create a sinking fund for the redemption of the bonds.

Convict Labor Laws

The leasing of the State convicts to corporations, firms, or individuals, was abolished by the laws enacted in 1919.

All able-bodied State convicts, except 75 to be retained on the State farm, are required to work on the public roads of the State under the supervision and control of the State road department.

The county commissioners of the various counties may employ county jail prisoners under sentence of crimes upon the public roads and bridges of the counties or they may hire prisoners to other counties for road work, or in the event that no county will hire them they may be leased to contractors.

Automobile Registration

The registration of automobiles is made annually with the State comptroller. The rates are as follows:

Motor cycles, $2; passenger cars, 22 h. p. or less, $5; 22 to 27

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h. p., $8; 27 to 35 h. p., $12; 35 h. p. and more, $15; passenger cars used for commercial purposes with a seating capacity of 10 passengers or more, $100; motor trucks, 1-ton capacity or less, $10; 1 to 2 tons, $25; 2 to 4 tons, $50; 4 tons and over, $100. A minimum fee of $10 is allowed for motor vehicles used by undertakers. No fee is required for a trailer with a carrying capacity of 500 pounds or less. For trailers having a carrying capacity exceeding 500 pounds the rates are same as for motor trucks.

Road Funds

Funds for the support of the State road department and for State aid in the construction and maintenance of State-aid roads are derived from the net receipts accruing from the registration of motor vehicles, 15 per cent being used for the support of the department, while 85 per cent is used for the maintenance or construction of State or State-aid roads, and is apportioned to the various counties on the basis of State tax paid by each county into the State treasury. If the entire apportionment for any county is not required for the maintenance of State or State-aid roads and bridges, the whole or any part of it may be used for the construction of State and State-aid roads and bridges. The motor vehicle fund yielded approximately $425,000 during the year of 1919.

In addition to the motor vehicle fund there is also levied a State-wide tax of 2 mills on each $1.00 of assessed valuation. This fund will yield approximately $750,000 per annum and will be used to match Federal aid on State roads.

Progress Report

During 1918 the State entered into agreement with the counties and the Federal Government in the building of 136 miles of road costing $796,288.08 and consisting principally of the following types: brick 19, concrete 43, macadam 10, and sand-clay 54.

During 1919, it was expected that 150 miles of road would be built with Federal and State aid in cooperation with counties at a cost of $3,000,000 and consisting principally of the following types: brick 70, concrete 50, and asphaltic concrete 30.

State Highway Officials

State Road Department: M. M. Smith, chairman; L. C. Register, Jasper; Ed. Scott, Arcadia; J. D. Smith, Marianna; J. E. Gilbert, Jacksonville; Chas. A. Browne, State highway engineer; James Austin Mortland, bridge engineer; and J. P Clarkson, secretary. Headquarters, Tallahassee, Fla. Revised by J. P. Clarkson, secretary.

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GEORGIA

State Highway Legislation

Highway legislation in Georgia originally placed all road authority in the counties of the State, which now number 157. In 1916, a State highway department was created, unsupported by State funds, whose sole function was to handle the Federal-aid allotments to Georgia by acting as agent for the counties which furnished the money to match Federal aid. In the 1919 session of the general assembly a newly constituted State highway department, well supported from motor vehicle licenses and broadly empowered, was created having in prospect the expenditure of $2,000,000 income from the motor vehicle licenses beginning with 1920, in addition to administering the Federal aid allotments to Georgia.

The new State highway department embraces a State highway board of three men appointed by the governor for terms of six years with per diem compensation; a State highway engineer selected by the board; and a staff fixed by the board, but filled by direct employment of the engineer.

Cooperation with Federal Government.—Georgia has participated in Federal aid allotments since the passage of the act in 1916 to the extent of nearly $5,000,000, an equal sum being furnished by 86 counties of the State wherein 135 separate projects are located on the main highways. Forty-two projects are now under construction representing about $4,500,000 total expenditure. Total allotment to counties matched by county money aggregates nearly $10,000,000 of which about $2,000,000 is given to important bridge construction over the large rivers of the State. About 60 additional projects are practically ready for contract and 45 others are under survey. The new State law does not necessarily change the method of administration of Federal aid funds, but permits combination of both Federal and State aid in the discretion of the board.

Local Legislation

Administration of road and bridge affairs in the counties is vested either in an official, termed the "ordinary," or in a board of commissioners of roads and revenues, the boards consisting of from one to eight elective members, with terms ranging from two to six years. Because of the number of special acts and forms of procedure optional with county authorities a uniform organization of local road forces does not prevail throughout the State.

The counties levy direct property taxes for roads and

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bridges and use also a poll tax for roads. The figures vary in different counties. The felony and misdemeanor convicts are used as labor, being distributed to the counties by the State prison commission and entirely maintained at county expense. No system of accurate report of annual expenditure on roads from these sources is kept. It is commonly estimated that Georgia counties are now expending from county current funds not less than $4,000,000 on its total public road mileage of 83,000 miles.

Bond Legislation

Under the impetus of Federal aid, and in the hope that such aid will be permanent and annually increasing, many counties issued substantial amounts of road bonds during 1919. The aggregate so issued in 44 counties reached $16,000,000. Expenditure of this bond money is made in a number of cases dependent on the receipt of Federal aid on a 50-50 basis, and the sale of the bonds is to be in such amount from time to time as will meet the Federal aid received. Some of this bond money is now pledged against the Federal aid projects previously mentioned. It is impossible to say how much of this will be spent at an early date, owing to local control and limitation of the terms of issue. It is probably assured, however, that at least $2,600,000 of it will be used to meet the $2,600,000 of Federal aid allotted to Georgia for 1920. And it is probable that a much larger amount will be contracted owing to the eagerness of the counties for paved roads. The new law carries a promise of reimbursement of the cost of State roads to the counties, but postpones the repayment until the 4,800 miles embraced in the State system of roads is completed.

Convict Labor Law

Georgia has used convict labor for a number of years distributed to and supported by the counties. The number of available convicts has diminished during the war period. The number of counties has increased, so that 3,000 convicts divided among 157 counties yields very small working units in many of the counties. The overhead costs plus the increased cost of feeding, guarding and clothing them are becoming burdensome in some cases. Some counties are leasing their quotas to other counties under this pressure, but there is no widespread movement to give up the system.

Automobile Registration

The growth in automobile registration is rapid. The record for 1918 was about 95,000; that for 1919 exceeded 120,000.

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Motor vehicle licenses under the new law are based broadly on 60 cents per h. p. for passenger cars, and $15 per ton capacity for trucks up to 4-ton trucks, the rates rising rapidly for larger capacities and reaching $1,125 for trucks of 7 tons or over. The rates are designed to discourage the use of very heavy capacities.

State Road Funds

It is estimated that the income for 1920 for use on the system of State roads derived from automobile registration fees will amount to about $2,000,000. No State money was available for 1919.

Progress Report

Lacking any system of reports to the State it is impossible to give any reliable statement of annual progress. Counties have been active in repairs and new construction of the prevailing sand-clay and top-soil roads. The repair costs have mounted heavily with the rapid growth of automobile and truck service. It is from this main cause that the sentiment for paved roads has sprung which crystallized in the legislation for State roads recently enacted. Further legislation is contemplated to remove constitutional restrictions and provide a direct issue of State road bonds for more rapid paving of the State system.

State Highway Officials

State Highway Board: C. M. Strahan, Athens, Ga., chairman; R. C. Neely, Waynesboro, Stanley S. Bennett, Quitman; State Highway Engineer, W. R. Neel, Walton Bldg., Atlanta; Assistant State Highway Engineer, J. H. Johnston, Walton Bldg., Atlanta; Chief Field Engineer, B. C. Milner, Walton Bldg., Atlanta; Attorney of the Board, H. J. Quincey, Ocilla.

Prepared by Prof. C. M. Strahan, Chairman, State Highway Board.

HAWAII

The Territory of Hawaii has done considerable work in reconstructing and resurfacing roads. Large portions of this have been carried on by commissions appointed by the Governor and serving in the various counties. These bodies are charged with the expenditure of money realized from the sale of Territorial bonds and allotted to the various counties by the legislature.

The maintenance of roads in the Territory is taken care of by the county boards of supervisors from the general revenues and revenues derived from taxes on vehicles, automobiles, etc. A tax

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of 1 cent per pound on autos must be paid before the car can be registered with the police department.

The latest type of road construction in the Islands has been concrete, mostly with an asphalt or asphalt-macadam wearing surface. In some cases the concrete is reinforced. On the Island of Oahu, near Honolulu, there is available $500,000 for the construction of this type of road, and a contract has been let for the first section, for about $180,000.

The legislature of 1919 made available $3,000,000 to be expended on roads whenever the United States Congress passes legislation which would put Hawaii on the same basis as the various States now under the Federal Aid Act of 1916.

Governor of the Territory, C. J. McCarthy, Superintendent of Public Works, Lyman J. Bigelow. Offices, Honolulu.

Prepared by B. S. Rixenbaurgh, secretary to delegate in Congress from Hawaii.

IDAHO

State Aid Legislation

The original highway department was created by the 1913 legislature and the 1915 legislature recreated it. The 1919 legislature passed a bill which reorganizes all State departments and institutions. Under this bill the State highway commission is abolished and its duties assumed by the commissioner of public works.

Under the general supervision of the director of public works, there is a director of highways who shall be a civil engineer of not less than 5 years' experience in road building. He is appointed by the governor.

The department of public works has power to lay out, build, construct and maintain State highways and bridges at any place within the State; to purchase, condemn or otherwise acquire the necessary lands for right of way, etc., for State highways; to cooperate with and receive aid from the Federal government, and to receive and expend donations from other sources for the construction and improvement of any State highway; to contract jointly with counties and highway and good-road districts for the improvement of State highways; to prescribe and enforce rules and regulations affecting State highways; to investigate methods of road construction and to establish standards of construction and maintenance of highways adapted to different sections of the State; to keep records of all State highways, including surveys, plans, specifications and estimates, and, so far as practicable, of all highways in the State, and for that purpose

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to demand and to receive reports and copies of records from local road officials; to advise, assist and cooperate with local officials upon request in the planning, building, and constructing of local roads.

Construction work on State highways, of which about 4,000 miles have been laid out, is carried on by the State in conjunction with the Federal government, counties or highway districts. State funds are used to pay one-third the cost of construction and the counties or highway districts, and when possible Federal funds, the balance.

All contracts are let by the commissioner of public works and the work is done under the supervision of the director of highways. Upon completion the roads are maintained by and at the expense of the State.

Federal-aid funds with which to cooperate with the Federal government are raised by a State-wide levy of 2 mills and by bond issues voted by county commissioners and commissioners of highway districts.

Local Legislation

Jurisdiction of roads is vested in boards of county commissioners, or boards of highway commissioners of highway districts, who usually appoint a director of highways for each district. Property taxes may be assessed at rates not to exceed $1 on each $100 of assessed valuation. A poll tax, payable in cash, is also levied at a rate of $4 per capita.

Bond Legislation

There are two classes of road districts authorized by law to issue bonds. Since 1905 it has been lawful for any portion of a county containing 25 or more resident taxpayers, by a majority vote of the resident freeholders at an election ordered by the county board of commissioners and petitioned for by a majority of the freeholders, to organize and become a good roads district. Three good roads commissioners chosen at this election are authorized, with the consent of two-thirds of the qualified freeholders expressed at an election, to issue bonds in any amount not exceeding 25 per cent of the assessed real property valuation in the district, and the proceeds must be used exclusively for road purposes. These bonds shall bear interest not to exceed 6 per cent, run for not more than 20 years, and not be sold for less than par.

Under an act of 1911, 50 or more freeholders of lands wholly within a county aggregating 20,000 acres or consisting of less contiguous territory that has an assessed valuation of $1,000,000,

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provided that these freeholders own at least 10 per cent of all the property in the proposed district, or a number of resident freeholders equal to 20 per cent of the voters, may petition the county board of commissioners for an election, at which the majority vote decides for the organization of a highway district. If the vote is favorable, the district is organized with three highway commissioners, with terms of four years each. The first of these commissioners are appointed by the governor, their successors are elected. The commissioners constitute a highway board and have authority by resolution to issue coupon bonds for road purposes at not exceeding 6 per cent interest, and payable within 20 years by a sinking fund provided. If the proposed bonds increase the outstanding bonded debt of the district the resolution shall provide for an election, and a two-thirds vote is necessary to authorize them. The bond issue shall not exceed 10 per cent of the assessed valuation of all property in the district.

Convict Labor Laws

The director of highways is authorized to make requisition upon the warden of the State penitentiary for convicts for road labor, subject to the rules and regulations of the board of prison commissioners. The warden and prison commission assign such prisoners as they deem physically able and at the same time reasonably safe to work on the State highways, and prisoners are to be paid $5 monthly for their services.

Automobile Registration

The law provides for annual registration with the Secretary of State through the assessors of the various counties. The schedule of fees is as follows: 2,000 pounds or less, $15; more than 2,000 pounds and not exceeding 3,000 pounds, $20; more than 3,000 pounds and not exceeding 4,000 pounds, $30; more than 4,000 pounds, $40.

The counties retain 75 per cent of the fees to pay the interest on any road bonds which may be outstanding to be used on the county roads, and the remaining 25 per cent is forwarded to the State treasurer, who deducts 10 per cent of the amount to pay the interest on outstanding State highway bonds, and the balance is used for State highway maintenance.

State Road Funds

The State has voted highway bonds in the sum of $200,000. This, together with 2-mill State-wide tax, which will produce approximately $1,850,000 per annum, and the income from motor

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vehicle licenses, $150,000, constitutes the available fund for the State's share of highway construction and maintenance. In addition there is a $2,000,000 bond issue up for vote at the next general election.

Progress Report

During 1917 and 1918 the total mileage of graded State highways was brought up to about 500 miles; and during this period a large number of small bridges were built, the largest being 300-foot span. This work involved the expenditure of approximately $1,300,000.

State Highway Officials

Commissioner of Public Works, Wm. J. Hall; Director of Highways, DeWitt P. Olson; headquarters, Boise.

Revised by D. P. Olson, Director of Highways, Department of Public Works.

ILLINOIS

State Aid Legislation

Supervision over road affairs is vested in the division of highways of the department of public works and buildings. The highway division is administered by a superintendent of highways and a chief highway engineer, both appointed by the governor with the advice and consent of the Senate, and other subordinate employes whose number and compensation are fixed by the State law under a budget system. All employes are subject to the Illinois civil service laws, except the superintendent and chief engineer, who receive salaries of $5,000 per year each.

The department of public works and buildings has complete control over all Federal aid and State funds, and has the right to prescribe rules and regulations relative to the duties of its employes and of county superintendents of highways.

There are two systems of roads to which the State extends aid, namely, 1st: State roads, comprising about 4,800 miles, which are being built and maintained entirely at the expense and under the direction of the State out of the $60,000,000 bond issue. Included in this system there are 780 miles of road which are being built at the joint expense of the State and Federal government. The department of public works will prepare plans and specifications, determine type, let contracts, purchase machinery and materials and, in fact, do everything there is required for the proper expenditure of the funds and the completion of the system.

2d. State-aid roads, comprising about 11,200 miles, selected by

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the State and local authorities and constructed on a 50-50 basis by the State and counties. These roads are constructed and maintained under the supervision of the State from plans, specifications and estimates prepared by the State and approved by county boards. Types of surfacing on the State-aid roads are selected by county officials subject to State approval, but in order to encourage the selection of the more durable types of improvement the State agrees to pay 100 per cent of the cost of maintenance of the more durable types, such as cement concrete, bituminous concrete, brick, or other hard-surfaced types, patented or otherwise. The State pays one-half of the cost of maintenance, provided the road is built with gravel or macadam, but it will pay no portion of the cost if it is built of earth. If a State-aid road is not properly maintained by the county, future allotments of State aid may be withheld until the road is properly maintained.

No State-aid work was undertaken during 1919 or 1920, as all State forces and funds were concentrated during that period on the State system.

The highway department may undertake and supervise local construction to which no State money is applied when requested by local officials to do so, and on request it is required to furnish plans, specifications and estimates of proposed improvements initiated by local officials.

Federal Cooperation.—Upon the request of the office of public roads shortly after the passage of the Federal Post Roads Act, the department of public works and buildings selected a system of highways to be known as the Federal-aid roads. This system consists of two roads running east and west, forming parts of two transcontinental highways, namely, the Lincoln Highway, crossing the northern part of the State, and the National Old Trails, crossing the southern part of the State.

The department selected as the north-and-south road the Dixie Highway from Chicago to Danville; a road connecting Chicago and St. Louis via Joliet, Ottawa, LaSalle, Peoria and Springfield; and a road extending north from Chicago through Waukegan to the Wisconsin State line.

This system comprises the most important roads in the State of Illinois, both from a national and State standpoint. It includes approximately 780 miles, of which 150 miles has already been improved either by the cities, counties, or townships, leaving 630 miles still to be improved. Of this 630 miles, there have been constructed or are now under construction 550 miles, and the remaining 80 miles is put under contract. Contracts call for

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completion of approximately 400 miles in 1919 and the remainder in 1920.

Local Road Legislation

With the exception of roads already improved as State aid, Federal aid or county bond-issue roads, all of the roads in the State are under the jurisdiction of township or district highway commissioners and the county superintendent of highways.

Each county has a county highway superintendent, appointed by the county board after a competitive examination for the place held by the State highway authorities. No part of the State road and bridge fund may be apportioned to a county until it has appointed such a superintendent. His term is 6 years and he is regarded as a deputy to the State highway engineer. In case the office is vacant and a temporary emergency requires some qualified official to discharge the duties, the State highway engineer may appoint someone to perform these duties temporarily.

The county highway superintendent prepares the plans, specifications and estimates for all county bridges, subject to their final approval by the State highway authorities, supervises the construction and maintenance of all roads and bridges under exclusive county control or joint county and town or district control and advises the town or district highway officials on the maintenance and improvement of roads and bridges, and supervises the maintenance of State-aid roads in the county under the direction of the State highway authorities.

The control of local roads is exercised in two ways. In counties not under township organization, the county boards divide the territory into road districts which are the local administrative units for highway purposes exclusively. In counties under township organization the several towns have authority over the roads. In either case the roads are in charge of a single highway commissioner in each township or road district. The local road tax of a town or district is determined by its commissioner annually. Any contract for construction, machinery or materials exceeding $200 must be approved by the county highway superintendent.

Bond Legislation

State Bonds.—The $60,000,000 State highway bond issue, voted by the people at the general election in November, 1918, by a vote of 661,815 for and 154,396 against, will bear interest at the rate of 4 per cent. The bonds are to be of the serial type, payable within 20 years, the interest and principal being paid from the proceeds derived from the motor-vehicles fund, or, if that is not

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sufficient, from a State-wide tax. They are to be issued as needed.

Convict Labor Laws

Prior to 1915, convicts were not worked outside prisons except in quarries getting out rock for State use. Crushed rock and other road material produced by convict labor is furnished free at the penitentiary, where prepared, to the State highway commission for permanent road improvements. In 1915 convicts were worked on local roads on requisition from town highway commissioners, a charge of 50 cents per man per day being made for board. Three or four convict camps were worked and about 25 miles of macadam road constructed by them.

Automobile Registration

Motor vehicles are registered with the Secretary of State. Effective January 1, 1920, the rates for passenger cars carrying not to exceed 7 persons are as follows: 25 h.p. and less, $8; 25 to 35 h.p., $12; 35 to 50 h.p., $20; over 50 h.p., $25. Motor bicycles, $4; electrically propelled motor vehicles, $12. The rate for motor vehicles carrying more than 7 passengers and for motor trucks for pulling or carrying freight are: For vehicles the gross weight of which amounts to 5,000 pounds or less, including the weight of the vehicle and maximum load, $12; 5,000 to 12,000 pounds, $22.50; 12,000 to 15,000 pounds, $35; 15,000 and over, $60; tractors and traction engines, $25; dealers' and manufacturers' license fees amount to $12 for each set of duplicate tags. The weight of motor vehicles is limited to 16,000 pounds per axle or 800 pounds per inch of the average width of tire, in actual contact with road surface. The gross load may be increased 50 per cent on special permits in cities having a population of more than 20,000. On September 15, 1919, a total of 457,445 cars had been registered.

Road Funds

The Fifty-first General Assembly in 1919 made available for road improvement during the next biennium, all from motor-license fees, the sum of $15,000,000. In addition to this sum appropriations have been made as follows from unexpended balances of former appropriations: State-aid fund, $937,677.91; Federal-aid fund, $1,060,194.90, making a total appropriation of approximately $17,000,000.

Of this sum approximately $1,200,000 in connection with a like sum, which has already been appropriated by counties to meet the allotment made to the counties in 1917 and which was not

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expended last year because of war conditions, will be expended on State-aid road construction. No provision has been made for State-aid allotments during the years 1919 or 1920.

Of the above appropriations, $300,000, or so much of the amount as may be required, will be used for maintenance purposes during the period from July 1, 1919, to July 1, 1921. The State is now maintaining about 700 miles of State-aid roads. It is expected that about 500 miles will be added this year and 1,200 miles next year, so that at the beginning of 1921 there will be a total of approximately 2,400 miles to be maintained.

There has been allotted to the State of Illinois by the Federal government from the Federal post-road appropriation the sum of $12,000,000. This, together with the remainder of the total appropriations above referred to, some $15,500,000, will be used in improving the Federal-aid roads of this State.

All of these funds, totaling $27,500,000, to which should be added $3,000,000 which the counties are furnishing to improve Federal-aid roads, are in addition to the sum to be derived from the sale of the $60,000,000 bonds voted in November, 1918. This sum of $60,000,000 was also appropriated to the department of public works and buildings by the 51st General Assembly.

From the amounts thus appropriated must be paid the engineering and inspection costs, as well as the cost of actual construction work.

Contracts were awarded in 1919 for approximately 620 miles of construction on Federal-aid roads and 100 miles on State-aid roads.

The annual allotment of State road funds to a county bears the same ratio to the whole appropriation that the total road and bridge tax of the county does to the sum of such taxes in all counties; except in counties where over 40 per cent of the total amount appropriated for roads by the legislature is collected, including automobile licenses, the allotment of State funds shall equal 25 per cent of the amount so collected in each of the counties. State aid is not permitted to exceed half the cost of an improvement. A county which does not appropriate within six months of the date of the State allotment at least an equal sum, forfeits its allotment, which is distributed among the counties fulfilling the law.

If a county desires to construct a State-aid road more rapidly than funds can be provided in the manner just indicated, the law authorizes the county to advance the necessary funds and construct the road at any time. In this case, any allotment of State-aid funds may be used either to defray half the cost of a

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new road or to pay off county bounds or other obligations issued to construct State-aid roads at the county's expense, provided the total State aid used in the latter way does not exceed half the cost of constructing such roads, which must comply when finished with the plans, specifications and estimates of the State highway engineer. Bonds so issued must be specifically authorized by a majority vote of the electors and must mature in not less than 10 nor more than 20 annual series.

There is an annual highway poll tax of $1 to $3 in each township or road district, payable to its treasurer by every able-bodied male resident, unless this form of taxation for local roads is abolished by vote of the electors of the town or district. The property tax levied by township commissioners for local highway purposes must not exceed 66 cents on each $100 valuation. This tax yields more than $14,000,000 annually and is used for the construction and maintenance of township roads. An additional tax of 13½ cents per $100 for damage incident to the laying out of new roads, relocation and drainage may be levied. Not less than $3 nor more than $5 per mile per annum of the road funds of a township or road district must be used for dragging earth roads.

Progress Report

During the period covering January 1, 1917, to January 1, 1919, there were completed 543.68 miles of State-aid roads at a total cost of $2,993,625.69.

The following types of construction are included in this mileage: brick, 29.2 miles; concrete, 68.91 miles; bituminous concrete, 1.51 miles; bituminous macadam, 10.91 miles; bituminous resurfacing and surface treating, 3.20 miles; waterbound macadam, 22.62 miles; gravel, 32.42 miles; oiled earth, 117.87 miles; earth, 257.04 miles. There was also complete during this period 166 bridges on the State-aid system at a total cost of $120,228.38.

A total of 129.69 miles of road and 17 bridges were constructed in many of the counties of the State from funds provided through county bond issues or from funds otherwise appropriated for the purpose. The total cost of the road construction was $1,316,161, and for the bridges $5,112.30.

The following types are included in the mileage of roads constructed: brick, 9.37; concrete, 84.75; bituminous concrete, 7.34; bituminous macadam, 2.45; gravel, 0.38; earth, 25.39. Up to September 27, 1919, contracts were being awarded for approximately 540 miles of construction of Federal-aid roads and 100 miles of State-aid roads.

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State Highway Officials

Department of Public Works and Buildings: Frank I. Bennett, director; Thos. G. Vennum, assistant director. Office at Springfield.

Division of Highways: S. E. Bradt, superintendent of highways; Clifford Older, chief highway engineer; B. H. Piepmeier, engineer of construction; Frank T. Sheets, engineer of design; Frank L. Roman, testing engineer; Geo. F. Burch, bridge engineer; H. B. Bushnell, maintenance engineer; J. M. McCoy, chief clerk.

District Engineers in Division Highways: George N. Lamb, Aurora, District No. 1; H. E. Surman, Dixon, District No. 2; J. E. Huber, Ottawa, District No. 3; A. H. Hunter, Peoria, District No. 4; R. L. Bell, Paris, District No. 5; Fred Tarrant, Springfield, District No. 6; C. M. Hathaway, Effingham, District No. 7; C. M. Slaymaker, E. St. Louis, District No. 8; Lloyd Schwartz, Carbondale, District No. 9.

Revised by S. E. Bradt, State superintendent of highways, Department of Public Works and Buildings.

INDIANA

State Aid Legislation

The legislature of 1919 provided for the creation of a bipartisan State highway commission composed of four members appointed by the governor for terms of one to four years, the term of one commissioner expiring each year. Each commissioner receives a salary of $10 per day for the time actually employed. The commission appoints a director who is the executive officer of the commission. The commission also appoints a chief engineer who is in charge of the division of construction, a superintendent of maintenance who is in charge of the division of maintenance, and a chief clerk who is in charge of the division of auditing. All employees of the department are selected and retained on merit and are required to pass such examinations as may be prescribed by the commission. The salary of all employees of the department, including the director, is fixed by the commission subject to the approval of the Governor.

The law provides that the State highway commission shall at the earliest possible moment proceed to lay out a system of State highways which shall reach each county seat in the State and each city or town of over 5,000 inhabitants. At present (Sept. 1, 1919), the commission is engaged upon this task. About 800 miles of the system has been designated. It is expected that the

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complete system will contain from 3,000 to 3,500 miles when the designation has been completed.

All State highways will be constructed and maintained under the direction of the State highway commission and entirely at the State's expense, except certain sections of the system which will be built at the joint expense of the State and the Federal Government. Approximately all work of the State highway commission during 1919 has been done under Federal cooperation.

Local Legislation

Road administration in the county is vested in a board of three commissioners, one being elected each year. There are also ex-officio boards of directors for all free gravel, macadam and turn pike roads, and appoint a county highway superintendent who has charge of the maintenance of all county roads.

The county surveyor is ex-officio engineer of the county, or in case of his inability to execute and to supervise engineering work the commissioners may appoint an engineer. The board may also appoint a county highway superintendent to have the general supervision of the maintenance and repair of all county highways and bridges.

The 1919 session of the Legislature passed what is known as the county unit law, which provides that the county may ask and receive supervision of construction and review of plans and specifications by the State highway department, on petition of 50 or more freeholders to the county commissioners. The expense of this review and superintendence of construction is charged back to the county by the State highway department.

Road affairs of townships are under the jurisdiction of township trustees, one from each township, elected for terms of four years. They are assisted by supervisors elected for terms of two years by the voters of each district into which each township is divided.

Counties may levy a tax at a rate not to exceed one cent on each $100 of valuation for each 10 miles of county road for the maintenance of improved roads. In the townships, a tax not to exceed 30 cents on each $100 of valuation may be levied for road and bridge purposes. Two-thirds of this tax may be worked out on the township roads provided that an additional tax, paid in cash, of 10 cents on each $100 valuation be levied for road and bridge purposes.

Bond Legislation

Serial bonds in an amount not exceeding 4 per cent of the assessed valuation of the county or township may be issued for

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road and bridge purposes. The bonds are issued by county commissioners on a petition signed by 50 freeholders. They bear interest at the rate of not to exceed 4½ per cent, and are generally limited to 20 years. They are retired by an annual tax levied by the commissioners on all the property in the townships.

Convict Labor Laws

The managing board of the State reformatory and State prison may, wherever there is no work for the inmates within the prison, arrange with the county commissioners or township trustees for working the convicts on the roads.

Automobile Registration

The registration of automobiles is under the jurisdiction of the Secretary of State. The annual fees for passenger cars are as follows: less than 25 h. p., $5; 25 to 40 h. p., $8; 40 to 50 h. p., $15; 50 h. p. and more, $20; manufacturers' and dealers' licenses, $25; duplicate numbers for manufacturers and dealers, per set, $1; for electric passenger vehicles, $5; motor cycles and chauffeur's license, $2.

The fees for trucks and delivery cars are as follows: one-fourth ton capacity and less than three-fourths, $6; three-fourths to 1 ton, $8; 1 to 2 tons, $10; 2 to 3½ tons, $20; 3½ to 5 tons, $30; 5 to 7½ tons and over, $50. The fee for each trailer is one-half the fee of the car to which it is attached. No truck of more than 10 tons capacity is permitted on the highways of the State.

State Road Funds

The State highway fund is derived from three sources: (1) The State-wide tax of 39/100 of one mill on each $1.00 of all assessable property in the State, which is expected to yield approximately $2,520,000 per year; (2) all net receipts from the registrations and fees derived from the automobile registration for 1920 and thereafter. It is expected that this fund will yield during 1920 approximately $2,500,000; (3), receipts from the State inheritance tax which yields approximately $500,000 per year. About $1,200,000 of the 1918 State funds were carried over to 1919. During 1919, the State had at its disposal about $4,220,000 and during 1920 will have about $6,720,000. This money will be used principally in meeting Federal aid funds and will be expended on the State highway system.

Progress Report

The State highway commission let contracts for about 134 miles of improved State highway during the season of 1919.

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Approximately 300 additional miles and $1,000,000 for bridges exceeding 20-foot span will be contracted for during the season of 1920 if the present plans of the commission are carried out.

State Highway Officials

D. C. Jenkins, chairman; Archy Campbell, John Oliphant and Earl Crawford, members; L. H. Wright, director; H. K. Bishop, chief engineer, division of construction; A. H. Hinkle, superintendent of maintenance and repair; and Mrs. H. N. Freeman, chief clerk, division of audit. Headquarters, Indianapolis, Ind.

Revised by H. K. Bishop, chief engineer.

IOWA

State and Local Legislation

The road building organization of Iowa consists of a State highway commission, 99 boards of supervisors of the 99 individual counties and 1,652 boards of township trustees.

The work of the State highway commission is conducted through a chief engineer who is the active head of the organization. The road building activities of the individual counties of which the supervisors have charge is under the direct supervision of a county engineer in each county.

The first highway commission was established in Iowa in 1904. The members of the commission were the dean of agriculture and the dean of engineering at Iowa State college together with the dean of engineering at Iowa State University. The duties of this commission were entirely of an advisory nature.

The general assembly of 1913 established the present highway commission giving it general supervision of all road and bridge work in the State. The commission was instructed to prepare standard plans, designs, and specifications for all necessary types of highway bridges and culverts. It was also instructed to prepare plans, designs and specifications for the township and county roads into which the roads of the State were at that time divided. County roads consisted of approximately 15 per cent of the 100,000 miles of road in Iowa, or 15,000 miles. The balance of the roads or the highways comprised the township road system of the State, about 85 per cent, or approximately 85,000 miles.

The county road system in each county was maintained and all new constructions built under the direction of the county engineer and the board of supervisors, but according to the plans either prepared or approved by the State highway commission. The township road system was maintained by the township

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trustees, but when construction work of a somewhat permanent nature was attempted on this system the trustees were required to call in the county engineer for advice and assistance and all construction was required to be in accordance with the standard plans prepared by the State highway commission for township roads.

Funds for the township roads were secured almost entirely from township road and bridge levies. Funds for the county road work were obtained from the county road and bridge levies and the county's share of the automobile fees. County road funds and their expenditure were entirely in the hands of the county road officials. Township funds were entirely in the hands of the county road officials.

The State highway commission had no funds to spend on either road maintenance or road construction. The only fund at the command of the State highway commission was 5 per cent of the State automobile fees which was used solely as a maintenance fund for the commission. The State worked under this arrangement from 1913 until the end of April 1919. There was no provision in legislation for State aid of any kind in road building in either counties or townships, nor was there any authorization for bonds for road or bridge building to be issued either by the State, county or townships.

The General Assembly of 1917 instructed the State highway commission to select from the most important highways of the State a system of roads connecting every county seat and the more important market places of the State. This system of roads was not to exceed 6,000 miles. The roads were to be selected by the highway commission with the advice and help of the boards of supervisors and county engineers. The legislature designated that this road system was to be called the Inter-county system. The greater portion of its mileage was taken from the county road systems. The same legislature also provided for the acceptance of the Federal aid money by the State and the setting aside of such a portion of the State automobile fees as might be necessary to match the Federal money dollar per dollar. The Federal money and the fund derived from State automobile fees was called the Federal County Coöperation road building fund. This money was apportioned to the various counties according to the area of the county. There was still no provision for bond issues for road building either by State, county or township and no other method of anticipating road funds was provided.

In response to an urgent State-wide demand for more permanent highways, the 38th General Assembly in 1919 provided a

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financial system whereby the State and the individual counties might hard surface the more important portion of their highways. The inter-county road system was adopted by the legislature as the primary or State road system. The State automobile license fees were approximately doubled and the increased funds thrown into a fund called the primary road fund, the Federal-county co-operation road fund being discontinued. The Federal allotments were also thrown into this same fund. This fund, it was instructed, should be used exclusively on the primary road system. No portion of it was to be spent on either the county or township systems. The county and township funds were somewhat increased and were left exclusively for use on the county and township road systems.

The primary fund is distributed to the various counties in proportion to their areas. The net balance in this fund on January 1, 1920 amounted to $5,046,770. The expenditure of the money is made by the boards of supervisors under the supervision of the State highway commission. The expenditures of every kind except maintenance must be upon projects approved by the State highway commission and the district office of the U. S. Bureau of Public Roads. Maintenance of the primary system, which is entirely paid out of the primary fund, is by the county officials. But the law provides that in case the maintenance is neglected, or is not entirely to the satisfaction of the commission, the commission may take over the work and charge the cost to the county's share of the primary road fund.

All bridge and culvert building costs on paving county and township systems must be paid by the county from county road levies. All cost of grading, drainage, and similar work on the primary system is paid from the primary road fund. When paving projects are contemplated, part of the cost is paid by the abutting property.

It is also provided that no hard surfacing can be done until the county at a popular election votes to authorize the general policy of hard surfacing. Provision is made that counties, if they desire to hard surface portions of their primary road system faster than the work can be done by the annual allotments which become available, may, after a vote of the people, issue bonds. The principal of these bonds is to be paid by the annual allotments from the primary road fund to the county, but the interest upon the bonds must be paid by the county through a mileage levy.

In case of hard surfacing any highway, 75 per cent of the cost is paid from the primary fund. The remaining 25 per cent is assessed against the abutting property 1½ miles back from each side of the road, making a benefit zone of 3 miles wide. Pro-

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vision is also made for hard surfacing portions of the county and township road systems. In case of an improvement on the township road system the county road funds must pay 25 per cent of the cost, the township road funds 50 per cent, and the remaining 25 per cent is assessed against the abutting property. In case of improvement on the county road system the county funds must pay 75 per cent of the cost and the remaining 25 per cent is assessed against the abutting property.

Convict Labor Laws

State convicts may be worked at stone quarries and the crushed stone produced furnished to the county or township f. o. b. cars at the crushing plant.

The highway commission experimented in 1915, 1916, and 1917 very satisfactorily with groups of convict laborers on road, bridge, and culvert building. They were paid at that time 22½ cents per hour. Out of this the convicts paid the entire expense of their camp and the necessary officials and guards in charge of the men in camp and at work.

The prison garb was discarded and the men dressed like ordinary workmen. The majority of the men were intelligent workmen and the results were entirely satisfactory both to the county and to the officials.

Automobile Registration

The present automobile law (1919) provides for an annual registration with the Secretary of the State with fees as follows: 20 h. p. or less, $8; each additional h. p., 40 cents; all electric and steam vehicles, $15; motorcycles, $3; manufacturers and dealers, $15.

Under the new motor vehicle registration law, effective June 1, 1920, fees are to be as follows: One per cent of the factory list price plus 40 cents per 100 pounds weight of the vehicles. The minimum fees is to be $10. Motorcycles have a flat rate of $5.

All fees are collected and the plates delivered by the county treasurer who forwards all collections to the State treasurer, where it is credited to the primary road fund. Two and one-half per cent of the gross revenue of the motor vehicle license fees is set aside for the State highway commission, as a maintenance fund.

Road Funds

The total expenditures for road and bridges in 1918 were $14,095,752. It is estimated that records in 1919 will show an increase of probably $1,000,000 over these figures. The 1918

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records show a total of $3,000,856 expended on county roads, $3,430,882 for township roads and $6,808,818 for bridges and culverts on county and township road systems. Figures for 1919 will show a considerable increase in each of these totals. Between April 1 and September 15, 1919, 13 counties voted $18,475,000 in road bonds for hard roads, and up to January 30, 1920 a total of 29 counties had voted for hard surfacing.

Progress Report

The total mileage of all roads of Iowa outside of incorporated towns and villages is 104,000. This is divided as follows: Primary road system, 6,288 miles; county road system, approximately 10,000 miles; township road system approximately 88,000.

Up to the present time there are approximately 15 miles of road improved by hard surfacing consisting of either concrete or brick pavement; 1,202 miles have been surfaced with gravel; 2,475 miles have been put to permanent grade with grades reduced to a maximum of 6 per cent, all cuts and fills made and adequate drainage provided. Five hundred and thirty-two miles are nearly to a permanent grade with only slight grade reductions, and cuts and fills yet to make; 10,714 miles have been put to standard cross section by means of tractor grader outfits, but cuts and fills on these roads have not been made. The 2,475 miles of permanently graded road is ready for the laying of hard surfacing. This comprises a little over one-third of the primary road system.

State Highway Officials

State Highway Commission: J. W. Holden, Scranton, Iowa, chairman; Dean A. Marston, Ames, Iowa, William Collinson, Chariton, Iowa; Fred W. White, chief engineer; J. H. Ames, bridge engineer.

Prepared by J. W. Eichinger, bulletin editor.

KANSAS

State Aid Legislation

The State of Kansas is not permitted, at the present time, to give aid in the construction of highways, owing to a constitutional limitation. At the 1919 legislature a constitutional amendment was passed, which will be submitted to the voters at the general election in 1920, which provides that the State may engage in the construction of roads and highways to the extent of 25 per cent of the cost of such road or highway, and not more than

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$10,000 per mile, nor more than 100 miles in any one county except in counties having an assessed valuation of more than $100,000,000 where such aid and reimbursement may be granted for not more than 150 miles of road or highway. This constitutional amendment further provides that the State may reimburse the counties for road constructed after March 1, 1919.

The 1917 legislature created the State highway commission for the purpose of coöperating with the Federal Government in Federal aid road construction. The commission consists of the Governor, ex-officio chairman, and two members appointed by the Governor with four-year terms. The State highway engineer, secretary and other employes are appointed by the commission for an indefinite period. It was further provided that the counties were authorized to raise the money to furnish the State's share of the cost of constructing Federal aid highways and that the construction would be in complete charge of the State highway commission.

Local Legislation

The jurisdiction of county roads is vested in the board of county commissioners and the county engineer and of township roads in the board of township highway commissioners and road overseer, with the necessary approval of the county engineer, in some cases. The county commissioners of the county are required to appoint, subject to the approval of the State highway commission, a county engineer to supervise the work on all county roads and to assist the township officials in improving and maintaining roads under their jurisdiction, also to prepare and approve plans for bridges constructed by the townships. The township highway commissioners are required to employ a road overseer to supervise the construction and maintenance of township roads and mail routes. The State highway commission has general supervision over all road and bridge work in the State. All county road systems must be approved by the State highway engineer and the work performed on this system be in accordance with plans approved by the State highway engineer. All bridges on county roads must be built in accordance with plans approved by the State highway engineer and all bridges on township roads the cost of which exceeds $2,000 must first be approved by the State highway engineer.

Bond Legislation

On a petition of 51 per cent of the resident land owners owning 35 per cent of the land or 35 per cent of the resident land owners owning 51 per cent of the land, or the owners of 60 per

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cent of the land lying within a benefit district, the petition naming the type or types of improvement, the width or widths, the terminal points and other specifically fixed locations and the number of annual assessments, not less than 10 nor more than 20, to be made in payment therefor, the county commissioners are authorized to improve the road if it is found to be of public utility. The county commissioners are empowered to make contracts or to construct the road by the day labor system and to issue bonds in payment therefor, bearing interest not to exceed 5 per cent annually, within the time mentioned in the petition. The county commissioners are further authorized to coöperate with the State highway commission for the purpose of securing Federal aid under the benefit district law. All plans, specifications and estimates for the improvement must be submitted to the State highway engineer for approval before the work is started, and on Federal aid work the construction is under the direct charge of the State highway engineer.

After all Federal aid, donations or subscriptions have been deducted, the cost is distributed as follows: 50 per cent to the county, 25 per cent to the townships in the benefit district on a ratio of the land in the benefit district lying in each township and 25 per cent to the land in the district. The charge against each piece of land in the district is determined by the county commissioners according to the benefits that accrue to the land and the improvements thereon. Each land owner in the district is given an opportunity to pay his portion of the cost in cash or to allow it to run for the term of the bonds. The county is required to pay for all bridges costing over $2,000 or having a span greater than 20 feet.

The county commissioners are also required to call an election for issuance of bonds to construct at least 30 miles of road upon petition of 20 per cent of the resident land owners within the county. They are also authorized to make a special levy for the construction of at least 30 miles of road when a petition is filed and carried by an election, the levy not to exceed 3 mills on the dollar annually. The county commissioners are also authorized to levy a general road tax of not less than one-fourth and not more than 1½ mills for the purpose of constructing and maintaining the county road system.

The bridge levy authorized by law is not to exceed one and one-half per cent for county bridge work and the county is not authorized to construct a bridge costing over $25,000 in certain counties and $50,000 in other counties without submitting the question to vote; but by submitting the question to an election and by a majority of votes cast the county is authorized to issue bonds

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for five-year period for the construction of larger bridges. The board of township highway commissioners is authorized to levy not to exceed 3 mills for road and bridge construction.

Convict Labor

State convicts may be employed on roads or for the preparation of road building materials, but none have been so employed to date on account of the scarcity of prisoners at the penitentiary. County prisoners may be employed on road work.

Automobile Registration

The law provides for annual registration with the Secretary of State. The schedule of fees is as follows: Motor vehicles, $5; motorcycles, $2; dealer's license, $15, which provides for a license and three number plates; motorcycle dealer's license, $4. The revenue is paid into the county treasury and on each license fee collected 50 cents is paid to the Secretary of the State for the upkeep of his department. The remainder is distributed as follows: where the fee is collected in cities of the first or second class, the entire balance goes to the county for the dragging of designated county roads. When the fee is collected in cities of the third class or the county at large outside of the cities, the fee is divided one-half to the county and one-half to the township, the county's share being used for dragging designated county roads and the township's share for dragging township roads and mail routes. The law provides that when the roads are not sufficiently improved to be maintained by dragging the money may be used for the maintenance of State roads and that all unexpected funds shall be placed in the general road fund at the end of the fiscal year.

Road Funds

The estimated expenditure for road purposes during 1918 was $7,220,232.98. These funds were provided by township and county road taxes and automobile registration fees.

For 1919, there is available $9,581,273 for road and bridge purposes as follows: County road and bridge fund, $4,411,307.32; township road and bridge fund, $3,165,791.41; automobile fees, $962,697.00; Township general fund (one-half), $541,477.35; township poll tax (estimated), $500,000, making a total of $9,581,273.08.

Progress Report

The total mileage of public highways in Kansas, exclusive of the streets of incorporated towns and cities is about 111,052.

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Approximately 20 per cent of these roads are now in the county road system. The county roads are mostly earth roads, fairly well graded and maintained. There are only about 450 miles of improved roads consisting of gravel, macadam, brick and gravel and about 900 miles of sand-clay and oiled earth roads in the State. Federal aid road construction has been completed upon 2.1 miles of brick road and contracts have been let for 85 miles of road of brick, concrete, gravel and macadam. Road work financed to date amounts to $44,000,000, covering about 1,500 miles of road, all to be constructed with Federal aid if sufficient funds can be obtained from the Government.

State Highway Officials

The State Highway Commission consists of Governor Henry J. Allen, ex-officio chairman; R. S. Tiernan, of Fort Scott, commissioner; A. C. Blair of Lyons, commissioner; M. W. Watson, State highway engineer; W. C. Markham, secretary; W. V. Buck, assistant State highway engineer; F. W. Epps, bridge engineer; C. I. Felps, C. C. Jones and L. P. Scott, division engineers.

The State highway commissioners are appointed by the governor for a term of four years, one is appointed west of the 6th P. M., and one east thereof. Their terms of office expire alternately every two years. The State highway engineer, secretary and other employes are appointed by the commission for an indefinite period.

Prepared by M. W. Watson, State highway engineer.

KENTUCKY

State Aid Legislation

The department of public roads, first established in 1912, is headed and administered by a State commissioner of public roads appointed by the governor for a term of 4 years. The first appropriation for the administration of the department amounted to only $25,000 per annum, the department being empowered only with advisory and educational duties.

The General Assembly of 1914 passed a bill which levied a State tax of 5 cents on the $100 of taxable wealth, which was to constitute a State road fund to be redistributed to the counties applying for aid to the extent of one-half the cost of construction or reconstruction of public roads, no county to receive in any one year more than 2 per cent of the total fund.

Another bill was also passed in 1914, making roads connecting the county seats of adjoining counties, on the most direct and

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practical route, public State highways, to be the first to receive State aid. This system comprises about 8,000 miles.

The special session of the legislature in 1917 reduced the State road tax from 5 cents to 3 cents on $100 of taxable wealth. This, however, did not reduce the funds available, due to the fact that at the same session the general tax laws of the State were so changed that the 3-cent tax provided as much revenue as the former 5-cent tax.

The regular session of the General Assembly of 1918 further amended the State-aid law so as to provide for coöperation with the Federal government in building Federal-aid roads. The commissioner of public roads was authorized to enter into contracts and agreements with the United States government relating to survey, construction, and maintenance of roads under the provisions of Federal-aid law. To pay for the State's portion of the cost of construction and maintenance of rural post roads, there was appropriated from the fund provided by the State-aid act amounts equal to those allotted to Kentucky by the United States government.

Local Legislation

County road and bridge affairs are as a rule administered in the 120 counties by fiscal courts composed of the county judge and a magistrate from each magisterial district of the county. There are a few counties in which road affairs are administered by three or more commissioners who are elected by the people. All of the above officials are elected for terms of four years. The county clerk is clerk to the governing body and the county treasurer is fiscal agent.

The governing body of the county may appoint as county engineer one who is required to be either a reputable civil engineer or a man who has had two years' practical experience as a road builder and who shall have passed an examination held by the State commissioner or his representative. He serves as the executive official of the county in all road and bridge matters and receives general instructions from the State commissioner relative to standards and types of construction, gradients, etc., of all public roads and for plans for all bridges costing $500 or more.

Current revenues are obtained from an ad valorem tax levied at a rate not to exceed 50 cents on each $100 of taxable property, one-half of which may be used for road purposes. A poll tax may be levied for road purposes on male inhabitants over 21 years of age at rates which vary in the different counties. These funds are expended by the fiscal court or other governing body

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for all county purposes, including road and bridge expenditures. Six days' statutory labor on the roads may be required for all able-bodied male citizens between the ages of 18 and 45, but this tax is not generally observed. The fiscal court may authorize counties to vote on an additional tax of 20 cents on the $100 valuation for road purposes.

Bond Legislation

On the petition of 150 voters and freeholders of a county, the county court shall call an election to determine whether bonds of the county shall be issued in an amount not to exceed 5 per cent of the taxable valuation of the county. If two-thirds of the legal voters voting shall favor the issuance of bonds, the fiscal court may issue them, to bear not exceeding 5 per cent interest, to run not less than 5 nor more than 30 years, and to be sold for not less than par. The fiscal court shall levy an annual tax of not to exceed 20 cents on each $100 valuation of taxable property in the county, to pay the interest on such bonds, and to create a sinking fund for their redemption at maturity. Sinking-fund accumulations may be loaned by the fiscal court on first mortgage real estate security, on the basis of 50 per cent of its value.

Any county which issues bonds and expends the proceeds thereof for building public roads under the direction of the commissioner of public roads, in an amount greater than the amount which said county may be able to secure by apportionment from the State road fund for that year, shall be entitled to receive from the State road fund in subsequent years such further amounts or apportionments as will make the total amount ultimately received from said fund equal to one-half the amount so expended by said county.

Convict Labor Laws

The State may employ the State convicts outside the walls of the penitentiary in road or bridge work, or in the preparation of materials therefor. Eight convict labor gangs are at present engaged in State-aid operation under this law.

County prisoners sentenced to work at hard labor may be placed in the work house, if there be one in the county, or at work upon the public works, or roads, of the county, or upon the public works of any city or town in the county. The place of working such prisoners shall be determined by the county judge, giving preference to work on roads of the county whenever the weather will permit. When placed upon the public works of any city or

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town, such city or town shall provide and pay for food, lodging, and guarding; and when placed on the county roads, such cost shall be paid out of the road funds of the county. The county judge is authorized to appoint a manager for each crew of prisoners, who shall also act as guard. No crew shall consist of less than three prisoners, and not more than one man shall be paid to guard and manage less than 10 prisoners. The county or fiscal court shall have power to prescribe regulations for the government of prisoners and those in charge of them. All prisoners placed at hard labor shall be permitted to satisfy their fines and costs with such labor at the rate of $1 per day.

Automobile Registration

The legislature of 1918 changed the automobile license fees materially, as applied to trucks, providing that for trucks with a capacity of 1,000 pounds and less the fee should be $11, while for those with a capacity of more than 9,000 pounds the fee should be $75. The fees for passenger cars were unchanged. They are: On less than 25 h.p., $6; 26 to 49 h.p., $11; 50 h.p. and over, $20; manufacturers and dealers, one vehicle in each class at regular rates. There are approximately 90,000 cars in the State, which yield to the State treasury about $700,000 annually.

Road Funds

In 1919 the State road fund will probably amount to about $1,300,000, of which about $700,000 will be derived from automobile license fees and about $600,000 from the three-tenths of a mill State-wide tax. The same amount will be raised by the counties for State-aid roads. The State will have to its credit from the Federal government up to July 1, 1921, a total of $5,300,000, which will be duplicated by regular taxation or subscription for the purpose of building Federal and State-aid roads in the counties. It is estimated that local taxation (meaning taxation by counties) yields annually $3,125,000 in this State. From this sum must come whatever is apportioned by the individual counties towards consuming the counties' proportion of State and Federal aid.

Progress Report

To date seven Federal-aid projects have been proposed and approved, comprising approximately 1,000 miles. Seventeen projects (portions by counties of the above projects) have been submitted, eight of which are now being constructed, approximating an expenditure of $850,000.

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State Highway Officials

State Commissioner of Public Roads, Jos. S. Boggs, Frankfort, Ky.

Revised by Jos. S. Boggs, State Commissioner of Public Roads.

LOUISIANA

State Aid Legislation

In 1910, the State highway department was organized and the distribution of State aid in the form of money aid, and use of prison labor under the supervision of the State highway department, was made a permanent State policy.

A State highway engineer, selected by the board of State engineers, serves at its pleasure and is the executive official in charge of the State highway department. Such assistants as may be required by him are appointed by the board. The board of State engineers handles all questions of general policy relating to the highway department, and brings to the attention of the governor all matters pertaining to appropriations, new legislation, etc.

The State highway engineer, subject to the general supervision of the board of State engineers, is vested with broad powers over the contributions made by the State for highway improvement, the standards of construction for State-aid road work, and the selection and designation of a system of State highways, upon which State aid may be expended.

A State-wide system, comprising about 5,000 miles of road connecting parish seats and important commercial centers, has been selected by the State highway department for improvement by means of Federal, State and parish funds under the supervision of the State highway department. Initiative for construction or improvement of State roads rests with police juries of the parishes.

State aid may consist of money aid up to 50 per cent of the total cost of the improvement, dependent, however, on the funds available at the disposal of the State highway department. It may also consist of convict labor furnished by the State with the approval and under the rules and regulations of the general manager of the State penitentiary. The expenses of operating the convict road force are paid by the local body of board benefited.

After construction, State roads are maintained under the supervision of the State highway engineer with State and local funds in the same proportion as for construction.

State aid may not exceed $50,000 in any parish in any one year

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if other parishes apply for aid during that period. Neither may a parish obtain aid for two consecutive years, unless all other parishes applying for aid are supplied.

Local Legislation

The parishes in Louisiana correspond in size, organization, and power to counties of other States. Their affairs are administered by a police jury consisting of an elective member from each of the wards into which the parish is divided. The members elect one of their number as president and employ a non-member as secretary.

The police jury has jurisdiction over all road and bridge work in the parish, may levy taxes, issue bonds and in all respects is a body politician.

The parish's surveyor, appointed by the governor, who is not required to be a civil engineer, may, on order of the police jury, be employed on local road work.

Funds for local roads are derived from a general levy of one mill on the dollar of assessed valuation, by transfer of surplus from general funds, by the imposition of an annual license tax on all vehicles except automobiles, and by the imposition of a special tax when authorized by a majority vote of the property taxpayers eligible to vote in the parish, and by the net receipts of the State registration fees on motor vehicles collected and returned by State authority to the parish treasurer. There is also a per capita tax of $1 levied on all male inhabitants between the ages of 18 and 45 not otherwise legally exempt.

Bond Legislation

Bonds may be issued in amounts not exceeding 10 per cent of the assessed valuation of parishes or districts when authorized by a majority in number and assessed valuation of the property-owning voters. The term of such bonds may not exceed 40 years and the rate of interest may not exceed 5 per cent. The bonds must be retired annually, beginning at a date not later than 5 years from the date of issue.

Automobile Registration

Automobiles are registered with the Secretary of State, the rate being 25 cents per h.p. for passenger cars and $7.50 for motor trucks. The net receipts from registration fees are returned to the counties in which collected and are used for construction and maintenance of parish roads without State direction.

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Road Funds

Revenues for State aid in construction and maintenance of State roads and for the support of the State highway department are derived from the imposition of a State-wide tax levied at the rate of one-fourth mill on each dollar of taxable property. This tax produces approximately $350,000 per annum.

The State highway department had available for the year 1919 approximately $1,400,000 for the construction of State-aid roads. This includes the funds from the Federal government and the proceeds of the one-fourth mill State road tax above referred to.

Progress Report

Owing to war conditions very little State-aid road work was undertaken during 1918. The department's activities were directed chiefly towards completing the work then under construction. However, contracts for the construction of 44.4 miles of gravel road in four parishes were let, estimated to cost $325,000.

With the aid of the Federal government, the department undertook the construction of approximately 200 miles of new roads during 1919, most of which consisted of gravel.

State Highway Officials

Board of State Engineers: F. M. Kerr, president; Gervais Lombard, J. W. Monget, John Klorer, George Schoenberger, assistant engineers. Headquarters, New Orleans.

Highway Department of the Board of Engineers: F. M. Kerr, chief State engineer; Duncan Buie, State highway engineer; Chas. M. Kerr, assistant State highway engineer; W. F. Cooper, office engineer; Chas. F. Wood, secretary.

Revised by Chas. F. Wood, secretary.

MAINE

State Aid Legislation

The State highway commission appointed by the governor, with the advice and consent of the council, consists of three members. Their term of office is three years, one commissioner's term expiring each year.

The commission selects and appoints, with the approval of the governor and council, a chief engineer, upon terms to be fixed by the commission subject to the approval of the governor and council.

The chief engineer, under the direction and control of the commission, has general charge of the office, the records and all

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construction and maintenance work, and may, with the approval of the commission, employ necessary engineers, supervisors, assistants and help as he may deem necessary.

The commission is authorized to lay out, construct and maintain a system of State and State-aid highways, the State highways to be constructed wholly by the State from the bond issue and mill tax fund, and the State-aid highways to be constructed by the State and municipalities jointly. Both classes of highways are to be maintained under the direction of the commission, the cost to be borne jointly by the State and municipalities. The charge against the municipalities for maintenance of State highways shall be $60 per mile per annum; and for State-aid highways, one-half the actual expense, but not to exceed $30 per mile per annum.

Towns may cooperate with the State in the employment of a regular patrolman to perform maintenance work, in addition to that upon the State highway or State-aid highway, upon such mileage of road as shall be mutually agreed upon by the municipal officers of the town and the State highway commission. For each mile so maintained the towns shall pay to the State a sum equal to the average amount per mile of road raised by the town for the support of highways. This amount must be not less than $30 nor more than $60 per mile.

The commission has full charge in the letting of contracts for the construction of all State and State-aid highways. The commission may make contracts with towns for construction of State-aid roads without advertising for bids.

Towns may make the following appropriations and apply for State aid: Towns having a valuation of $200,000 or less may appropriate any amount not exceeding $300; towns having a valuation of over $200,000 and not over $800,000 may appropriate any amount not exceeding $533; towns having a valuation of over $800,000 and not over $1,000,000 may appropriate an amount not exceeding $600; and towns having a valuation of over $1,000,000 and not over $3,000,000 may appropriate in addition to the sum of $600 a sum of $66 for each $200,000 or fraction thereof valuation in excess of $1,000,000; towns having a valuation of over $3,000,000 and not over $4,000,000 may appropriate not exceeding $1,333, and towns having a valuation of $4,000,000 may appropriate in addition to the sum of $1,333 a sum not exceeding $133 for each additional $1,000,000 of additional valuation.

The commission from the funds for State-aid construction shall apportion to each town, which has conformed to the provisions of the act, for each dollar so appropriated, the following amounts: To each town having a valuation of $200,000 or less,

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$2.66 for each $1 appropriated by said town; to each town having a valuation of over $200,000 and not over $1,000,000, $1.33 for each $1 appropriated by said town; to each town having a valuation of over $1,000,000 and not over $1,200,000, $1.22 for each $1 appropriated by said town; to each town having a valuation of over $1,200,000 and not over $1,400,000, $1.13 for each $1 appropriated by said town; to each town having a valuation of over $1,400,000 and not over $1,600,000, $1.07 for each $1 appropriated by said town; to each town having a valuation of over $1,600,000, $1 for each $1 so appropriated by said town. The money appropriated by towns applying for State aid, with the amount apportioned by the commission, shall constitute a joint fund for the construction and permanent improvement of the State-aid highways in such towns.

Between the 15th day of July and the 15th day of August in each year municipal officers prepare and file with the commission suggestions for the improvement during the next calendar year of State-aid highways located in each town, accompanied by plans so far as practicable, setting forth the location of the highways and the nature of the improvement desired. The commission examines and reports thereon with its recommendations to the municipal officers on or before the 20th day of February following. Such reports are submitted to the voters of such towns at the next regular meeting.

To provide funds for the construction of State-aid highways, there is appropriated annually the sum of $300,000. For the construction of the State roads the treasurer of State is authorized under the direction of the governor and council to issue from time to time serial coupon bonds, not exceeding $2,000,000 in amount outstanding at any one time, payable at the State treasury within 41 years from date of issue; the interest on the bond issue and retirement of bonds to be provided for from the automobile license fees. No more than $500,000 of bonds shall be issued in any one year. The bonds outstanding are now $2,000,000.

The fund for maintenance and administration is augmented each year by the balance remaining on the 31st of December in the appropriation for State-aid highways; that is, so much of the State's appropriation for this purpose as has not been apportioned to municipalities on account of State aid is automatically carried into the fund for administration and maintenance for the succeeding year. This fund is further augmented by the balance remaining in the fund created by the licensing of automobiles after providing for the payment of interest on the bonds issued and a sinking fund for the retirement of bonds, also administration of

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the State highway department and the automobile registration bureau.

The maintenance of all the principal thoroughfares in the State, both improved and unimproved, is under the direction of the State highway commission, the work to be done at the joint expense of the State and the towns.

A resolve was passed by the legislature April 4, 1919, authorizing the issuing of bonds not exceeding $10,000,000 in amount at any one time, payable within 41 years, which bonds or their proceeds shall be devoted solely to the building of State highways and intrastate, interstate and international bridges. This resolve had to be voted upon by the people on the second Monday in September and thereafter passed upon by the legislature to be assembled for that purpose. These bonds carried by a vote of 5 to 1.

An act passed April 4, 1919, provided that a tax of 1 mill on the dollar shall annually be assessed upon all property of the State according to the valuation thereof, and shall be known as the mill tax highway fund. This fund shall be used for the construction of highways as defined in section five of chapter 25 of the revised statutes, except that not more than one-sixth of the fund shall annually be used for the construction of highways and bridges and other purposes contemplated by said chapter 25 and in accordance with the terms of any appropriate resolves of the legislature. Two hundred thousand dollars of the amount herein shall be added to the fund of $300,000 for State-aid construction as provided in section 34, chapter 25 of the revised statutes, and shall be applied to the construction of State-aid highways and shall be called State-aid highway fund. The balance of said mill tax highway fund shall be used exclusively for the construction of State highways, except so far as may be necessary to carry out the provisions of this section and meet the requirements of the national government in order for the State to receive Federal aid for highway construction, the State highway fund shall be expended equitably among the several counties of the State by the State highway commission.

Federal Aid.—Up to October, 1919, three projects had been submitted to the U. S. Department of Agriculture, aggregating 35.45 miles, the estimated total cost of which is $775,937.02.

Local Legislation

Jurisdiction over roads vests in the boards of county commissioners in the case of county roads and all roads in incorporated towns; all other local roads are under the boards of selectmen of the towns.

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Convict Labor Laws

Upon written application from county or municipal authorities the board of prison inspectors may direct that jail prisoners be worked on county roads.

Automobile Registration

The law provides for annual registration with the Secretary of State. The schedule of fees is: 15 h. p. or less, $5; 16 to 35 h. p., $10; over 35 h. p., $15; motor trucks and commercial automobiles having a capacity of 1 ton or less, $10; 1 to 2 tons, $20; 2 to 3 tons, $30; 3 to 4 tons, $40; 4 to 5 tons, $50; 5 to 6 tons, $65; 6 to 7 tons, $80; 7 to 8 tons, $95; 8 to 9 tons, $110; 9 and over 10 tons, $125; traction engines and log haulers, $10; motorcycles, $3; operators, including owners, $2.

Registration revenue is paid into the State treasury and credited to a fund for the repair, maintenance and construction of State highways. The annual receipts from automobile registration have increased from $138,500 in 1913 to about $700,000 in 1919. Of the latter amount, $125,300 was used for interest and reserve fund to retire State bonds, the balance remaining in the State treasury to be disposed of by appropriation for repair, maintenance or construction of State highways.

State Funds for Construction and Maintenance

The funds for State-aid construction in the 500 towns are made up of the amount furnished by the State and a similar amount raised by the towns. For this purpose there is an annual appropriation by the State of $300,000 for State-aid roads. To this is added $200,000 from the mill tax, also 1/3 of a mill, or about $200,000, for third-class roads, and 1/6 of a mill, or about $100,000, for special road work, making a total for State aid of about $788,721. The amount raised by the mill tax for 1920 is $577,442. From this it will be seen that there will be about $90,000 left from this source ,which can be used for State highway construction or maintenance. The amount raised by the towns for State aid in 1919 was $338,746.46. The funds for 1920 will be approximately the same.

Funds for State highway construction are furnished entirely by the State, the system being 1,300 miles in length. With the exception of the $90,000 above referred to, these funds are derived from a bond issue of $2,000,000, available for 1920. There is also available for 1920 the sum of $500,000 derived from State bonds for use in the construction of interstate and international bridges.

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The automobile fees are used to pay the expenses of the automobile bureau and to pay the interest and retirement of a previous $2,000,000 bond issue and the present issue of $2,000,000 for highways and the $500,000 for bridges. The balance of State automobile fees will be used for maintenance. The automobile fees for 1919 amounted to $685,570.25. The amount needed for maintenance in 1920 will be about $600,000, in addition to about $200,000 to be paid by the towns.

Progress Report

Statement of mileage and expenditures on State-aid roads, 1901 to 1918 inclusive:

Year	Miles	Cost
1901–1906	.....	$ 441,123.22
1907	363.02	172,816.96
1908	82.84	266,611.86
1909	79.54	288,484.49
1910	113.42	428,638.74
1911	111.57	421,779.57
1912	117.11	631,027.54
1913	169.66	871,072.09
1914	158.64	748,796.76
1915	176.74	676,049.29
1916	157.06	554,557.03
1917	114.31	566,623.46
1918	112.44	609,482.21
1919	147.88	947,971.89
	1,904.23	$7,625,035.11

80% gravel surface.
20% macadam, concrete, bituminous macadam, sand-clay and miscellaneous.

Statement of mileage and expenditures on State highways 1914 to 1918 inclusive:

Year	Miles	Expenditures
1914	44.02	$ 755,684.59
1914–1915	87.89	.....
1915	52.73	527,906.03
1915–1916	6.90	.....
1916	104.52	465,735.89
1916–1917	.....	.....
1917	32.14	441,930.98
1917–1918	25.00	.....
1918	37.61	655,475.71
1919	3.91	289,025.79
	394.72	$3,135,758.99

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State Highways

Summary	Miles
Gravel	270.21
Macadam	4.78
Concrete	11.80
Sand-clay	6.75
Bituminous macadam	63.36
Gravel and macadam	6.68
Clearing and grubbing	22.21
Grading	8.93
	394.72

Maintenance Work for 1919

Maintenance work during 1919 was performed generally by patrol maintenance. Four hundred and seventy-eight patrolmen were employed in caring for 4284.52 miles of roads in 475 towns. Of this mileage, 668.60 miles was improved State highway, 843.72 miles improved State-aid highway and the balance, or 2772.20 miles, was unimproved road. There was also maintained by special arrangement with the towns 74.12 miles of improved State-aid road.

A total expenditure for labor and material of $653,452.91 was made on this work, including $18,354.34 furnished by the State for road machine work. The State also furnished supervision and inspection for the work amounting to $25,156.02, making the total gross expenditure chargeable to maintenance of $678,608.93. Of this amount the State furnished $471,376.04 and the cities and towns furnished $207,232.89. The average expenditure per mile was $155.69.

On the 668.60 miles of improved State highway the expenditure for labor and material and supervision was $275,666.65 or an average expenditure per mile of $412.30. The expenditure on the 3615.92 miles of other road under patrol was, for labor material and supervision, $382,445.24, or an average expenditure per mile of $105.77.

State Highway Officials

State Highway Commission, Augusta.—Philip J. Deering, chairman; William M. Ayer, Frank A. Peabody; Paul D. Sargent, chief engineer; I. W. Barbour, assistant engineer State highways; L. D. Barrows, assistant engineer State-aid highways; A. J. Wiggin, superintendent of maintenance; L. B. Jones, bridge

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engineer; resident engineers, P. R. Keller, E. L. Merrill, L. O. Norwood, P. D. Simpson, E. J. Smith and S. B. Stewart; assistant bridge engineers, G. F. H. Bragdon and C. H. Gilman; chief supervisor, Frank C. Marston; supervisors, J. A. Carians, G. S. P. Brannen, C. G. Beckler, W. T. Allen, A. J. Avery, C. W. Shorey, H. M. Hart, A. D. Graffam, B. J. Libby, H. S. Towne, L. N. Lacaster, I. B. Hagan, L. B. Googins, G. W. Mawhinney, W. B. Holway, O. J. Parsons, O. V. Jenkins, G. M. Hardison, S. D. Rice, W. S. Jones and Burleigh Beane.

Revised by I. W. Barbour, assistant engineer, State highways.

MARYLAND

State and State-Aid Legislation

The State roads commission, consisting of three members appointed by the governor, has direct control over the construction and maintenance of a system of main highways through all the counties in the State, the cost of such construction and maintenance to be borne entirely by the State. The commission also has authority to approve applications for State aid on roads not included in the trunk line system, and when such applications are approved the plans and specifications are prepared by the State, the contracts are awarded by the counties subject to the approval of the State, and the performance of the contracts is supervised by the State.

The cost of State-aid roads is shared equally by the State and counties. The allotment of State funds to the counties is based upon road mileage. After the construction of a State-aid road, its maintenance devolves upon the State.

The system of trunk-line roads, built and maintained entirely at the expense of the State, was authorized by the legislature in 1908, and a State bond issue of $5,000,000 was authorized for this purpose. An additional bond issue of $1,000,000 was authorized by the legislature in 1910; in 1912 an issue of $3,170,000 was authorized; $6,600,000 in 1914, $2,700,000 in 1916 and $3,000,000 in 1918, making a total of $21,470,000.

The trunk line system is selected entirely by the State roads commission, and every stage of this work is completely under the control of the commission. A chief engineer selected by the commission is the executive officer and active head of the work. The funds for State-aid roads as distinguished from State roads are provided by direct appropriation. Funds for the maintenance of State highways are provided from the receipts of the commissioner of motor vehicles from license fees, etc.

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Federal Aid.—Under the Federal-Aid act passed by Congress, there has been apportioned to Maryland approximately $2,390,-749.06. Project statements have been submitted to the bureau of public roads on 37 sections of road aggregating 263 miles in length, with an approximate total cost of $7,225,000. Project agreements have been signed by the Secretary of Agriculture and the State roads commission for a total of 89.22 miles of road, the cost of which will be approximately $1,300,000.

Local Road Legislation

Jurisdiction over county roads vests in elected boards of county commissioners, who may employ competent civil engineers for the construction and maintenance of roads and bridges.

Convict Labor Laws

For the purpose of building and constructing or maintaining any road, bridge or highway or for the purpose of working any stone quarry operated by the State roads commission, the commission is authorized to make request of the board of prison control for as many inmates of the Maryland penitentiary or the Maryland house of correction as may be necessary for the purpose, and the board of prison control is directed to furnish them, together with a sufficient number of guards for the safekeeping of the prisoners while so employed.

Automobile Registration

The annual registration fees are paid to the commissioner of motor vehicles and are: 60 cents per h. p. for motor vehicles with pneumatic tires, with a minimum of $10; for a motor vehicle with solid tires and a rated capacity not exceeding 1 ton the fee is $20; not exceeding 2 tons, $40; 3 tons, $60; 4 tons, $100; 5 tons, $150; 6 tons, $300; and 7 tons, $500; $10 for trailers with a rated capacity not exceeding 1 ton after any motor vehicle, plus $20 for each additional ton capacity up to a maximum of 7 tons. Motorcycles, $5 per annum, plus $3 for a side car; $3 for bicycle with motor attachment; $25 for two sets of dealers' tags and $12 for each additional set available on all cars of a dealer not used for hire; $20 for four tags for motorcycles; $1.20 per h. p. for motor vehicles transporting persons for hire, other than vehicles operating on fixed schedules; motor vehicles operating on schedule for passenger service, fee per passenger seat per mile of total annual scheduled mileage, 1/20 cent for vehicles under 3,000 lbs., 1/15 cent for vehicles weighing 3,000 to 7,000 lbs., 1/6 cent for for vehicles weighing over 7,000 lbs.; fee for freight motor

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vehicles operating on schedule, per ton capacity per mile of total annual scheduled mileage, 1/5 cent for trucks weighing less than 3 tons loaded, 2/5 cent for trucks weighing 3 to 6 tons, 3/5 cent for trucks weighing over 6 tons; operator's license, $2; chauffeur's license, $3 per annum.

One-fifth of the net registration revenue is apportioned to the City of Baltimore for use on its roads and streets, and the remainder is expended for oiling, repair and maintenance of the modern State and county roads. Fines and forfeitures are paid into the State treasury for the same use as the registration revenues.

The commissioner of motor vehicles is authorized to expend from the receipts of his office each year not exceeding $1,000 for the erection of sign posts for the direction of and warning of danger to travelers. The commissioner is also authorized to employ deputies equipped with motorcycles to enforce the motor vehicle and traffic laws of the State and pay them from the receipts of his office.

No motor vehicle in excess of 90 inches width, or in which the limit of load is over 650 lbs per inch in width of tire, may be operated on the highways of the State without special permit from the State roads commission, if a State road, or the proper authorities of other roads. No motor vehicle of which the weight of truck and load exceeds 14 tons shall be operated on any highway.

State Road Funds

There was available for construction and maintenance of State and State-aid roads during 1919 a total of approximately $6,400,000, as follows: $4,500,000 from the State bond issue for construction of State roads; $1,500,000 from automobile revenues collected during 1918 for maintenance of State and State-aid roads, and $400,000 appropriated by the legislature for State-aid construction on a 50-50 basis. The automobile money does not include the funds turned over to Baltimore City, which consists of one-fifth of the total net collections.

Progress Report

In 1916, 118 miles of new State roads were begun, 20 miles completed and 1,049 miles maintained.

In 1917, 35 miles were begun, 42 miles completed and 1,177 miles maintained.

In 1918, 27 miles were begun, 55 miles completed and 1,288 miles maintained. During this period 85 miles of State-aid were begun and 82 miles completed.

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During 1919 the construction of 115 miles of State roads and 56 miles of State-aid roads was begun. These projects were about 75 per cent complete at the close of the season.

State Highway Officials

Chairman, Frank H. Zouck; G. Clinton Uhl and John F. Mudd, commissioners; chief engineer, John N. Mackall; secretary, Clyde H. Wilson; council, Albert C. Ritchie, attorney general; commissioner of motor vehicles, E. Austin, Baughman.

Prepared by J. N. Mackall, chief engineer, State highway commission.

MASSACHUSETTS

State Aid Legislation

A State highway work is now carried on by the division of highways of the department of public works. The division of highways is presided over by the commissioner of public works and two associate commissioners.

The duties of the division of highways relate to roads and automobiles. Its duties so far as they relate to the roads are: (a) The collection of statistics as to road materials and road conditions in the State, the making of maps, the giving of advice to local road authorities, etc.; (b) the laying out and construction of State highways, the improvement of certain town roads, and the supervision of maintenance of State highways.

The State highways are such as are designated by the division upon petition of the city government, the board of selectmen, or the county commissioners. As soon as the highway has been thus designated it passes under complete jurisdiction of the State department of public works, which has control not only of construction and maintenance but also of the location of water and gas mains, poles or other structures, the planting or cutting down of trees on the right of way, etc.

The cost of constructing State highways is borne as follows: 75 per cent by the State and 25 per cent by the county in which the highway is located, the State paying the entire cost on the first instance and collecting as a refund the 25 per cent from the county.

In order to aid the small towns, 15 per cent of the amount appropriated annually for State highway construction may be expended as follows: 5 per cent in towns of less than $1,000,000 valuation, upon petition, the town making no contributions; 5 per cent in towns of less than $1,000,000 valuation, the towns contributing an equal amount; and 5 per cent in towns of more

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than $1,000,000 valuation, the towns contributing an equal amount, which amount must be in excess of its average annual appropriation for roads for the last five years.

When any road has been constructed or improved, in whole or in part, with money furnished by the Commonwealth, and is not laid out as a State highway, the city, town or county shall at all times keep it in good repair and condition. The department of public works shall from time to time notify the authorities in charge of the road whenever it is not so kept in condition, and shall specify what repairs or improvements are necessary, and said authorities shall forthwith proceed to make the specified repairs and improvements. If not made within 60 days (unless further time is allowed) the department may do the specified work and pay for it from any money available for the maintenance of State highways or from the part of the motor vehicle fees' fund available for work on through routes in the towns (20 per cent of the net). The amount of such expenditures shall be collected back in the form of State tax, the money collected to be available for use for the same purposes for which the money so expended was available, or for the repair and maintenance of State highways: but in towns of under $1,000,000 valuation not more than $50 a mile per year; in towns with a valuation of over $1,000,000 and under $2,000,000 not more than $100 a mile a year, and in towns with over $2,000,000 valuation not more than $200 a mile a year shall be collected in any one year, but any balance shall be collected in succeeding years. The commission may upon petition exempt any town from the whole or part of such payment if in its judgment said payment would prove to be an undue burden.

The State department of public works maintains the State highways at the expense of the State in the first instance, and the counties are required to repay to the State 25 per cent of the amount expended from taxtion by the State for maintenance, except that part taken from motor vehicle fees; also the towns are required to reimburse the State one-half the amount of such expenditures not exceeding $50 a mile in towns under $1,000,000 valuation, and not exceeding $100 per mile in towns of from $1,000,000 to $2,000,000 valuation, not exceeding $200 a mile in towns from $2,000,000 to $5,000,000 valuation, and in towns of over $5,000,000 valuation not to exceed $2,000 a mile in the aggregate nor exceeding $500 a mile in any one year. The amount collected shall be credited to the appropriation for State highways and used again by the commission. The commission may upon petition exempt a town from the payment of any part of the expenditure for the repair of State highways.

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The State road construction revenues are derived from taxation, usually authorized for five years, one-fifth of the amount authorized to be expended each year during the five-year period. The appropriation is at the rate of $1,000,000 per annum. Of the automobile fees and fines, after deducting the expense of administering the automobile department, 80 per cent is applied to the maintenance of State highways, and 20 per cent is spent on through routes in the towns. The net fees, fines, etc., now amount to about $2,300,000 per annum. In addition, the legislature makes direct appropriations from time to time to meet special expenses and additional maintenance cost.

As indicating the manner in which the law is carried out in relation to road construction by the State department of public works, it may be stated that contracts are awarded by the department to the city or town in which the highway is to be laid out, if prices are satisfactory to the department and if the contract is acceptable to the local authorities. The work is then done by the local authorities under the direction of the department and its engineers. The contracts for State highway construction are usually based on given unit prices for each item of work, while the small town contracts are on the lump-sum basis. If the local authorities do not take the contract, bids are advertised for and awarded in the usual way.

Acts of 1918, chapter 155, provides for assistance by the State to towns of less than $3,000,000 valuation on the basis of road mile valuation, that is, the valuation divided by miles of road. The towns have to appropriate $12.50 per road mile where such valuation is under $5,000, to $125 where it is over $40,000 and under $50,000 per road mile. It figures out about $3 per $1,000 of valuation. The State may expend not to exceed $50 per mile. In 1918 $100,000 was appropriated by the State. Excellent results have been obtained in keeping the roads in fair shape in the poorer towns, although no reconstruction is attempted.

The organization of the State highway work is as follows: a central office at Boston with three commissioners, of which the commissioner of public works is chairman, a secretary, the various assistants in the highway division, the motor vehicle department, and a chief engineer. The State is divided into four divisions, each in charge of a division engineer, who has the necessary assistants and resident engineers, who are employed directly on the work.

Federal Aid.—The total apportionment by the Federal Government, including the fiscal year 1920, is $2,580,000. To date sixteen projects have been approved, involving 52 miles of road and an obligation by the government of $706,000. There are also

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eleven projects not yet approved covering 44 miles of road, of which the government's portion is $627,000.

Local Legislation

The local roads are under the boards of selectmen of the towns or under a superintendent of streets, or under direct road surveyors, as the towns from time to time determine. The county commissioners may, upon petition, lay out new roads or make specific improvements, and may direct towns and cities to make such improvements.

Convict Labor Laws

By chapter 633 of the Acts of 1913 there was a provision for using prisoners in improving waste and unused land. In 1915 this act was amended so that the county commissioners could make arrangements with the officials of any city or town or with the highway commission to work prisoners on any highway, the prisoners to be in the custody of the sheriff of the county.

There were 2½ miles of macadam road built in 1918 under the provisions of this act, solely by the labor of prisoners, and undoubtedly more will be built in the near future.

Automobile Registration

The law provides for annual registration with the State highway commission. The registration fees are as follows: Less than 20 h. p., $5; 20 to 29 h. p., $10; 30 to 39 h. p., $15; 40 to 49 h. p., $20; 50 h. p. and over, $25; motorcycles, $2; all commercial automobiles and trucks, $10 per ton or fraction thereof of capacity; dealers and manufacturers, $25; and $5 for each additional car over five demonstrated on the road; dealers and manufacturers' motorcycles only, $10; operators, including owners, $2, renewal fee $1 per year. Non-residents are exempt to such an extent as the State of their residence grants exemption to the residents of the State of Massachusetts. The term "non-residents" is defined to be those who have no regular place of abode or business in the State of Massachusetts for a period of more than 30 days in the calendar year.

The net registration revenue shall be expended under the direction of the State highway commission for maintenance of State highways, provided that an amount not exceeding 20 per cent of such revenue may be expended by the commission for the repair, improvement and construction of local roads used as through routes. All fines are credited to the same fund as registration receipts.

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Road Funds

The sum of $1,000,000 was appropriated for State highway construction during 1919 and the legislature also appropriated $4,000,000 to carry on this work in the four following years. The commission expects to have available for highway construction and maintenance this year about $4,500,000, including money received from the Federal government. While it is not possible to give accurate figures, it is likely that the cities and towns will expend about $12,000,000.

Sources, amounts and purposes of State road funds in 1919 were as follows: Appropriation from State bond issue for State highway construction, State paying three-fourths and counties paying one-fourth, $1,000,000; net receipts from automobile fees, 80 per cent of which is for maintenance of State highways and 20 per cent for through routes in towns, $2,300,000; appropriated reimbursements from towns for maintenance of State and town highways, $292,525; appropriations for equipment, $100,000; appropriation for bridge maintenance, $20,000; appropriation for gypsy moth, $10,000; appropriation for highway department, $68,500; total, $3,791,025.

Reorganization

A law passed in 1919 and taking effect December 1, 1919, abolished the highway commission and the commission on waterways and public lands and transferred their powers, obligations, etc., to the department of public works established by the act. This department is under the supervision and control of a commissioner and four associate commissioners, two of whom have charge of the division of highways and two of the division of waterways and public lands. The commissioner appoints a registrar of motor vehicles, who exercises all the rights, powers, duties, etc., formerly exercised by the Massachusetts highway commission relative to motor vehicles and the operation thereof.

State Highway Officials

Department of Public Works.—Commissioner of public works, Jno. N. Cole; associate commissioners, division of highways, Frank D. Kemp, Springfield, James W. Synan, Pittsfield; secretary, Frank R. Bieler; chief engineer, Arthur W. Dean.

MICHIGAN

State Aid Legislation

The State highway commissioner is nominated and elected by the people at the same time and in the same manner as the jus-

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tices of the supreme court. He is required to be a citizen of the State and may appoint two deputies, one of whom shall be a competent engineer skilled in road building, and such other assistants as may be necessary. His duties are to give instruction in road and bridge construction and maintenance, to collect statistics and distribute State reward funds or funds given to the State for such purposes by the United States Government or by individuals. He is required to give expert advice to the local authorities and is required to make a map of every township in the State showing the roads and their condition and location, kind and quantity of road materials, etc. His decision is final as to whether a road merits State reward, and he may withhold any portion of the reward until the road has been thoroughly tested.

The construction and maintenance of the State trunk lines is under the direct supervision of the State highway commissioner. Counties, good roads districts and townships pay varying percentages of the cost. The percentages are determined from population, State equalized valuation and trunk line mileage, and range from 5 per cent to 25 per cent of cost of construction and from 10 per cent to 50 per cent of the cost of maintenance. All construction projects must be advertised by the State highway commissioner, but townships, good roads districts and counties may contract to do the work at a price below the lowest bid, if all bids are rejected. The State highway commissioner is also authorized to contract with the townships, good roads districts and counties for doing the maintenance work under his direction.

Whenever any township or board of county commissioners or good roads district commissioners have made arrangements to improve a mile or more of public road by constructing a sand-clay, gravel, stone-gravel, gravel-stone, macadam, concrete or brick road and ask for an allotment of State reward, and file with the State highway department a profile of the highway to be improved, and make application for plans and general specifications, the State highway commissioner shall furnish the plans and specifications and allot the funds from the State treasury as the State reward if, after completion, he finds the road to be up to the required standard. Each surveyed township is entitled to receive State reward on not more than 4 miles of road in any one fiscal year. The reward is allotted as follows:

a. Every mile of well-graded road, with grade not exceeding 6 per cent, except where found impracticable and a steeper grade is recommended after examination by the State highway commissioner, with not less than 20 feet between side ditches, properly drained, with travel track not less than 9 feet, made of a mixture of sand and clay or other material, shall merit, if approved by the

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State highway commissioner, a reward or aid from the State of 25 per cent of cost up to $3,000 per mile.

b. Every mile of well-graded road having not to exceed 6 per cent grade, except where found impracticable and a steeper grade is recommended after examination by the State highway commissioner, width not less than 20 feet between ditches, well-drained, travel track not less than 9 feet, surface not less than 8 inches compacted gravel applied in not less than two courses, each rolled separately, shall merit, if approved by the State highway commissioner, a reward or State aid of 25 per cent of cost up to $5,000 per mile.

c. Every mile of well-graded road having not to exceed 6 per cent grade, with not less than 20 feet between ditches, well drained, travel track not less than 9 feet and having a foundation not less than 4½ inches of crushed stone, slag or other material compacted, and top course of layer of gravel not less than 3½ inches, shall merit, if approved by the State highway commissioner, a reward or State aid of 25 per cent of cost up to $5,000 per mile.

d. Every mile conforming to the above conditions as to grade, width, drainage, etc., and having a bottom course of gravel, slag or other material not less than 4½ inches thick after rolling and a top course of crushed stone not less than 3½ inches thick after rolling, shall merit, if approved, a reward or State aid of 25 per cent of cost up to $5,000 per mile.

e. Every mile conforming to the foregoing as to width, grade, drainage, etc., and having a surface of well-compacted macadam not less than 7 inches thick laid in not less than two courses, each properly bonded, shall merit, if approved, a reward or State aid of 25 per cent of cost up to $5,000 per mile.

f. Every mile conforming to the foregoing as to grade, drainage, etc., and having properly laid cement concrete or bituminous concrete not less than 6 inches in thickness, shall merit, if approved, a reward or State aid of 25 per cent of cost up to $7,500 per mile.

g. Every mile conforming to the foregoing as to grade, drainage, etc., and consisting of a paving brick surface laid on gravel, sand, broken stone or slag, the quality of brick, manner of laying and kind of inspection employed to be made to comply with the specifications made by, or approved by the State highway commissioner, shall merit, if approved, a reward or State aid of 25 per cent of cost up to $7,500 per mile.

Firm earth, gravel or macadam shoulders must be placed on each side of the concrete and brick 8-foot metal track.

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Two or more townships may act jointly in the improvement of boundary line roads.

The State highway department is required to design, construct and maintain all bridges of 30 feet clear span and over on State trunk line roads, provided the county, township or good roads district agrees to construct at least 3 miles of road, including the bridge site. The State highway department is also authorized to contract with counties, good roads districts and townships for the construction and maintenance of all bridges of more than 30 feet clear span on State reward roads, provided at least 3 miles of State reward road have been built or funds have been provided to build 3 miles within one year.

The 1913 legislature passed what is known as "the trunk line highway act," which delineates certain highways leading from town to town in the State, upon which townships and counties were entitled to double the State rewards mentioned above, when they built roads according to specifications drawn by the State highway department. The fixing of the location of these routes between towns, the preliminary surveys and the drafting of specifications was in the hands of the State highway department, while the construction of the roads was in the hands of the townships and counties through which they pass. The law provides that the total allowable mileage of trunk lines in any county may equal the number of surveyed townships multiplied by 3.

The 1915 legislature authorized the local township officials or, where the county road system had been adopted, the county highway officials and the State highway commissioner, to lay out additional trunk line mileage up to 3 miles per surveyed township.

The 1919 legislature authorized the State highway commissioner to lay out an additional 500 miles. This, added to the previous mileage, makes a total of about 6,000 miles of State trunk lines authorized.

The 1917 legislature passed a law assenting to the provisions of the Federal aid act of Congress and providing the machinery for taking advantage of that law. The 1919 legislature amended it to make it correspond with the trunk line act so far as local payments are concerned and provided that proceeds from the sale of State bonds would be available to pay the State's portion of the cost of Federal-aid roads.

Local Legislation

The commissioner of highways of each township has charge of township roads and the board of county road commissioners of each county adopting that system has charge of county roads.

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An assessment district law provides that a petition signed by 60 per cent of the abutting property owners may be presented to the board of county road commissioners where the county road system is in force or to the State highway commissioner elsewhere for the improvement of a portion of a leading public wagon road. A portion of the cost is borne by the local assessment district and the remainder by the townships benefited or the county where the county road system is in force.

Bond Legislation

In April, 1919, an amendment to the constitution was approved authorizing the legislature to provide for the issuance of bonds for road improvement in an amount not to exceed $50,000,000. The 1919 legislature authorized the issuance of bonds not to exceed $5,000,000 a year to be applied to road and bridge construction on the trunk line system.

The township board of any organized township, upon petition of at least 25 freeholders thereof, may submit to an election the proposition of issuing bonds of the township in an amount not exceeding 5 per cent of the assessed valuation thereof, for improving the roads therein under the commissioner of highways subject to direction of the township board, a majority of the legal voters voting is necessary to authorize the bond issue. These bonds shall bear not to exceed 6 per cent interest and shall run not to exceed 25 years, and the tax shall be levied annually to meet the interest and principal as fast as they become due.

Counties that have adopted the county road system may issue bonds to pay for such improvements as the commissioners of highways decide to make in an amount not exceeding 3 per cent of the valuation of property assessable for this purpose. Before issuing these bonds, the county board of supervisors must order an election to decide on the issue. A majority of votes cast is required to authorize the bond issue. Bonds shall not be sold for less than par and shall run for not exceeding 20 years. The rate of interest and method of payment are not specified.

Convict Labor Laws

County road officials may direct the employment of county prisoners confined for petty offenses upon the highways of the county.

The wardens of the State penitentiaries may, upon proper application from highway officials, put State prisoners to work in the same manner as county prisoners. State convicts may also be

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used in surface quarries and stone yards in preparing material to be used on the public highways.

Automobile Registration

All automobiles must be registered annually with the Secretary of State. The fees for steam and gasoline vehicles are 25 cents per h. p., plus 35 cents per 100 lbs. weight. The fees for electric vehicles are $1 per h. p., plus 35 cents per 100 lbs. weight. One-half the money is returned to the counties for road purposes and half is paid into the State reward fund.

State Road Funds

For 1919 the amount credited to the State highway department funds was estimated at $7,400,000, distributed as follows: Department administration, $241,350; surveys and plans and preliminary work, $55,000; State rewards, $1,000,000; bridge construction and maintenance, $200,000; maintenance of trunk line and Federal-aid roads, $800,000; assessment district administration, $50,000; State reward road maintenance, $40,000; construction, $5,000,000.

Roughly, about $15,000,000 was expended by the counties and townships of the State for the construction of roads during 1919.

Progress Report

During the fiscal year ending June 30, 1919, 797.315 miles of road were accepted for State reward, bringing the total detailed construction under the supervision of the State highway department up to 6,572.298 miles. It is estimated that at least 1,200 miles will be built during the fiscal year of 1920. Approximately 7,500 miles of road was completed January 1, 1920. The sum of $1,237,853 was expended during the fiscal year of 1919 in the payment of construction and repair rewards on State reward roads. The payment of rewards, making surveys and construction of bridges on trunk line roads totaled $1,396,350 during the fiscal year of 1919. Departmental expenditures were $35,318.45. Fifty trunk line bridges were built, costing $380,000.

State Highway Officials

Frank F. Rogers, State highway commissioner; Leland W. Carr and L. H. Neilsen, deputy highway commissioners; Wm. W. Cox, chief engineer. Headquarters, Lansing, Michigan.

Revised by Frank F. Rogers, State highway commissioner.

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MINNESOTA

State Aid Legislation

The present law provides for a State highway department of which the commissioner of highways is the chief officer. The commissioner is appointed by the governor for a term of six years, and is required to devote his entire time to the performance of his official duties. He must appoint as deputy commissioner of highways an experienced road builder and engineer, who has charge, under the supervision and control of the commissioner, of the technical work of the department. The necessary assistant engineers and other persons to carry on the work in the department are also appointed by the commissioner of highways, who fixes the compensation of all employees.

The commissioner, his deputy and the assistant engineers are required to give advice and engineering services to other State departments as the governor may require. The engineers shall also make all necessary surveys, plans and specifications for construction and give direct supervision to all State road work under rules and regulations prescribed by the commissioner of highways.

Any county board may, with the consent of the commissioner of highways, designate any established road as a State road and construct, improve and maintain the same under the regulations of the commissioner of highways. The system now embraces about 12,700 miles.

With the exception of the three large counties in the State, there is assigned by the State highway department an assistant engineer to each of the counties, who has direct charge of the road work for the county.

Surveys and plans are made by an assistant engineer and submitted to the commissioner of highways for approval. When such approval has been obtained the county board proceeds to do the work by contract or day labor under the supervision of an assistant engineer, who acts under the rules and regulations of the commissioner of highways.

The financing of construction and maintenance work on State roads is taken care of in the first instance by the county board and State aid is paid thereon up to the limit of the allotment to the county at the rate of 50 per cent of the cost of work for counties of over $15,000,000 valuation, 60 per cent for counties of over $10,000.000, 70 per cent for counties over $5,000,000 and 80 per cent for counties having a valuation of less than $5,000,000.

It is required that an assistant engineer of the department make

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a report on completed work, which, is approved by the commissioner of highways, is certified to the State auditor, who issues the warrants for State aid. This applies to both construction and maintenance.

In case any county board fails or neglects to maintain any State road, the commissioner of highways may cause it to be maintained with funds from the reserve maintenance fund, the amount so expended to be deducted from the next State-aid allotment to the county and credited to the reserve maintenance fund, or he may, after notice to the county board, revoke the designation of such improperly maintained State road.

Local Legislation

Jurisdiction over local roads lies with county and town boards. County boards of supervisors consist of four members elected for terms of four years while town boards of supervisors consist of three members elected biennially for each township. Each town has from one to four road overseers, appointed by the town board, who have charge of the work under the board's supervision.

Counties are required to construct and maintain State roads and to construct county roads. To finance this work the county board is authorized to levy a tax of not to exceed 10 mills each year, to which is added the State aid. The county may purchase equipment and do its work by contract or by day labor.

County roads are laid out on petition of 24 or more freeholders, and roads established by judicial proceedings, or roads traveled six or more years without having been established by proceedings also become county roads.

Towns are required to construct town roads and to maintain county and town roads. Town roads are laid out on petition of eight or more voting freeholders. The electors may vote a tax on the town not exceeding 15 mills and subsequently the town board may, in case of emergency, levy an additional 5 mills, to be used for construction and improvement of town roads, by contract or day labor, as the board directs. There is also a compulsory tax of one mill, which forms the dragging fund, used only for dragging the town and county roads and for purchasing drags.

Bond Legislation

The legislature of 1919 has submitted to the vote of the people, at the November, 1920, election, a constitutional amendment, establishing a State trunk highway system of 6,900 miles, to be constructed, improved and forever maintained by the State, pro-

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viding for the issuance of bonds of the State not to exceed $10,000,000 in any one year and not to exceed $75,000,000 outstanding at any time, and further providing for the retirement of the bonds with income to be derived from motor vehicle registration fees and taxes.

On petition of fifty or more voting freeholders, and a majority vote at the subsequent referendum, the county board shall issue bonds of the county in such amount as will not, with existing indebtedness, make the total indebtedness of the county exceed 15 per cent of the taxable valuation of the county, the funds to be used for hard surfacing or otherwise permanently improving any established county road.

On petition of 15 or more voting freeholders of a town and a 60 per cent favorable vote at the town meeting, the town board shall issue bonds of the town, in amount not exceeding the cost of the proposed improvement and not exceeding, together with outstanding indebtedness, 5 per cent of the assessed valuation of the town, for the purpose of improving any established highway in the town.

Up to January 1, 1921, any county board may issue bonds of the county up to $125,000 on a four to five vote and up to $250,000 on a unanimous vote of the county board for permanently improving a State road, for which the commissioner of highways may apportion Federal aid, and which work is approved by the State commissioner of highways and is essential or preparatory to pavement of such road, providing the aggregate net indebtedness of the county shall not exceed 15 per cent of the valuation of the county's taxable real property.

Convict Labor Laws

No legislation provides for convict labor upon highways. They may be and are used for crushing stone on the prison grounds, for highway purposes as directed by the State commissioner of highways.

Automobile Registration

Triennial registration motor vehicles with the secretary of State is required, fees being as follows: For the triennial period beginning January 1, 1919, $5 on all motor vehicles, after January 1, 1919, $3.50 for the two following years, and after January 1, 1921, $2 for that year. The dealer's registration is $20 and $1 for each extra set of tags.

A law has been passed extending the present registration until new legislation is passed by the legislature in 1921.

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Road Funds

The State road and bridge fund is created by an annual tax levy of one mill on each dollar of taxable valuation, all money accruing from investments of the internal improvement land fund, 5 per cent from the sale of U. S. lands, proceeds from milk and cream testing licenses and the net proceeds from motor vehicle licenses.

The commissioner of highways, State treasurer and State auditor acting as a board of allotment, shall annually apportion to the State road and bridge fund, first setting aside an amount not exceeding $50,000 as a reserve maintenance fund, and a sum not exceeding 10 per cent of the State road and bridge fund as an administration fund for the Sate highway department. The remainder, which annually approximates $2,000,000, is allotted to all of the counties of the State with the legal limitation that no county shall receive less than 1 per cent nor more than 3 per cent of the fund. Twenty per cent of the allotments so made shall be set aside as aid for maintenance of State roads, but more than 20 per cent may, by resolution of the county board and approved by the commissioner of highways, be provided for such maintenance.

Progress Report

During the year 1918, the following highway expenditures were made under the supervision of the State highway department:

Road construction, grading 1,206 miles, graveling 640 miles	$3,146,867.13
Bridge construction, 640 structures	942,118.88
Maintenance on 12,089 miles	1,000,866.62

These funds were derived from the following sources:

State funds	$1,870,336.01
Counties	3,300,216.08
Federal aid	224,357.76

In addition to the above, approximately $5,000,000 was spent by towns and counties without State supervision.

During 1919 the following amounts were available on highway work:

State fund	$2,529,049.32
County levies	5,398,000.00
Federal aid	7,589,643.00
County bonds	14,607,500.00

During 1919, there was under construction 1,800 miles of grading, 650 miles gravel surfacing and 90 miles of paving. In addi-

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tion to these funds, the towns levied $4,315,000, to be spent on local roads.

State Highway Officials

Charles M. Babcock, commissioner of highways; John H. Mullen, deputy commissioner of highways and chief engineer; J. T. Ellison, chief bridge engineer; O. L. Kipp, construction engineer; W. F. Rosenwald, maintenance engineer; S. C. Notestein, chief clerk.

Division engineer: C. A. Forbes, R. K. Bliler, M. J. Hoffman, W. E. Matters, S. R. Green, J. J. Davy, D. W. Webster.

Revised by John H. Mullen, deputy commissioner of highways.

MISSISSIPPI

State Aid Legislation

In 1916, a State highway commission was created, but no provision has been made for the use of State funds for road construction. The law creating the department provides that if the legislature approves a bond issue for carrying out the commission's recommendations, the issue must be authorized by a majority vote of the electors. The commission and the State highway engineer appointed by it constitute the State highway department.

The State highway engineer is required to plan the improvement of such main roads, with their bridges, as will form a connected system of highways throughout the State, and the improvement of other roads designated by the commission; to ascertain the methods of construction and maintenance best adapted for all local conditions within the State; to give advice regarding bridges and buildings to local officials. The law requires county and road district highway officials to secure his approval of their plans, specifications and estimates before submitting them to the higher local officials for adoption. County and district officials are required to furnish to him upon request information regarding their roads and bridges, and are liable to a fine of $10 to $100 if they fail to do so. The department must hold at least one meeting annually in each county, if requested to do so, to discuss highway matters with the county and district road officials. The apparatus and supplies of the University of Mississippi and the State Agricultural and Mechanical College may be used by the department for testing road and bridge materials.

Funds to meet Federal aid are raised by counties and are expended under direction of the State highway department.

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Local Legislation

The State constitution prohibits the passage of local laws by the legislature exempting any person from road duty or relating to laying out, opening, altering, working and vacating roads. All such matters must be provided for by general laws.

Jurisdiction over all roads in a county lies in its board of supervisors. Each county is divided into five supervisors' districts, each of which may carry on its road work under the direction of three commissioners appointed by the board of supervisors. The county board may also place a county road commissioner in charge of the county roads or any part of them. Road districts containing at least 10 square miles may be formed to build roads under the direction of three road commissioners appointed for four years. An entire county may be organized as a road district. The district commissioners are authorized to do work by contract of day labor. District road systems may include street municipalities. A county board may require adjoining road districts to connect their road systems.

Bond Legislation

For the purpose of road and bridge improvement the county board of supervisors may issue bonds of the county to an amount not exceeding, including all of its bonded indebtedness, 5 per cent of the assessed valuation of all taxable property in the county. These bonds shall run not exceeding forty years, shall bear interest at the rate of 6 per cent, and shall be redeemed by a sinking fund to be provided for that purpose by annual taxation.

The board of supervisors of any county is authorized to issue bonds in an amount not to exceed in the aggregate, with outstanding bonded indebtedness, 10 per cent of the assessed valuation of the county, to construct and extend the public highways of the county to connect with the improved highways of adjoining counties, so as to form a continuous system of improved intercounty highways. Such bonds shall bear not to exceed 6 per cent interest and mature not later than forty years from date of issue.

Supervisor districts may issue bonds for road purposes on petition to the county board of supervisors signed by 20 per cent of the qualified electors of the district. A favorable vote by a majority of those voting at an election to be called for that purpose is necessary to authorize the issue. These bonds shall not run exceeding twenty-five years, shall bear interest not to exceed 6 per cent, shall be exempt from taxation and shall be sold for not less than par. A tax shall be levied annually to pay the

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interest and create a sinking fund for the discharge of such bonds at maturity.

The board of supervisors may require adjoining road districts, which have constructed, or are constructing, improved roads to connect such improved roads, and apportion the cost to the various districts. The board may, if necessary, authorize such districts to issue additional bonds to the amount required to make the connections. If 25 per cent of the electors of any such district, or districts, shall petition against such bond issue, it must be submitted to a vote, and cannot be made unless approved by a majority of electors.

Most of the improved roads so far constructed have been built in special districts from funds derived from bond issues. The general bonding law of the State providing for the improvements of roads in one or more supervisor's districts contains a number of interesting, sound and business-like features, namely:

1. Bonds may be issued by boards of county supervisors for a county or district on petition of 20 per cent of the qualified electors, provided the issue is not petitioned against by an equal percentage of electors, in which event an election must be held, when a majority vote decides the question.

2. The bonds outstanding must not exceed 10 per cent of the assessed valuation of property in the county or district.

3. The bonds must be paid off in annual installments between the tenth and twenty-fifth year from the date of issue.

4. A special tax must be levied annually for the payment of interest and principal, and the proceeds can be used for no other purpose.

5. A special tax of at least 1 mill must be levied for the maintenance of the road.

Convict Labor

There is no general convict labor law in reference to highways. Most convicts are employed upon State farms. The superintendent of the penitentiary is authorized to improve and maintian roads from each convict farm in the State for a distance of five miles out from said farms.

In four counties, convicts between the ages of eighteen and fifty sentenced to the farms may be required to work fifteen days on the roads.

Automobile Registration

Annual registration of motor vehicles is required with the payment of the following fees: Electric motor vehicles, $4.80; each commercial vehicle of 4,400 pounds capacity or less, $8.40;

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each commercial vehicle of more than 4,400 pounds capacity, $16.80; motorcycles, $2.40; any other motor vehicle, 36 cents per horsepower. Fees are collected by the regular tax collector, the county board of supervisors being required to furnish him with supply of licenses. Three per cent of the proceeds are paid to the collector for making collections and the balance goes into the road and bridge privilege tax fund of the county in which collected. Non-residents are exempt for sixty days.

Road Funds

No State funds are available with which to aid the counties or to meet Federal aid. The State highway department acts as agent for the counties in Federal aid construction. There is an appropriation of $10,000 per annum for the support of the highway department and the counties expend annually from taxation and bond issues approximately $10,000,000, about one-half of which is derived from county and district bonds.

State Highway Officials

The State highway commission: J. M. McBeath, chairman, Meridian; W. T. Denman, secretary, McComb City, and D. W. Robbins, Tupelo. State highway engineer, Xavier A. Kramer, Magnolia.

Approved by Xavier A. Kramer, State highway engineer.

MISSOURI

State Aid Legislation

State participation in road and bridge improvement is effected by means of a State highway department composed of a bipartisan highway board consisting of four members appointed for terms of four years each by the governor of the State, with the advice and consent of the Senate.

The board appoints a State highway superintendent who is required to be a practical and experienced road builder with at least five years' experience in practical road and bridge construction. He serves as secretary to the board, and in the absence of the board is granted executive authority over the department.

The State highway engineer, who has charge of construction of State-aid roads, is appointed by the board and is required to submit a detailed report each month to the State highway superintendent of the work accomplished under his direction. Two assistant engineers designated first and second assistant engineers,

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and such other employes as may be required, may be appointd by the State highway engineer with the approval of the board.

The members of the board receive salaries of $1,000 per year. The State highway superintendent and the State highway engineer each receive a salary which may not exceed $5,000 per year. The first assistant engineer and second assistant engineer receive not to exceed $3,000 and $2,500, respectively. The remaining employes are paid at rates fixed by the board.

The State highway engineer under the direction of the board is required to select a State highway system approximately 6,000 miles. This mileage is so chosen that each of the 114 counties will have at least 50 miles of State road, two of the roads are to extend through each county and in general are required to traverse the county in a north-south and east-west direction. This system will no doubt overlap the system of intercounty seat highways for which State aid is allotted to the various counties in the amount of not to exceed $25 per mile annually for dragging purposes. This latter system comprises about 11,500 miles and State aid for dragging purposes has been extended for several years.

Funds composed either of State and Federal funds combined, or of State funds, are allotted at the rate of $1,200 per mile to the various counties of the State for construction of sections of the system of State roads. This allotment is made on the basis that each county shall be allowed not less than 50 miles of State road. If in the opinion of the State highway board the allotment of $1,200 per mile is insufficient to construct the type of roadway required by present and future traffic, the board may require the county court or other governmental body to provide funds to defray one-half of the cost above $1,200 per mile, the remainder of the cost to be met from the State road fund, and in the event of the refusal of the county court or other governmental body to cooperate, the State highway board may reduce the mileage of construction, and so thereby increase the amount of funds available per mile.

Provision is also made for the construction of post roads at Federal and local expense, which may or may not be a part of the State highway system.

All construction on the State highway system is carried out under the supervision of the State highway department. When let by contract, the contracts are awarded by the board, or the work may be done by force account under the direction of the board.

Post roads not a part of the State system are improved at the expense of the U. S. Government and the county, district, or

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township benefiting. Construction is carried out by the county or township under State and Federal supervision.

Maintenance of all roads constructed with Federal or State aid, or at joint expense, is carried out by the county, district, or township having jurisdiction. Failure to properly maintain such roads to the satisfaction of the State highway board may result in the withholding of future allotments which may be due.

Local Legislation

Road administration in the counties is in the hands of the county court, which consists of three county judges. The county court appoints, if it desires, a county highway engineer, who has general supervision over all the roads and bridge work in the county. The surveyor of the county, which is a constitutional office, is elected by the people and is ex-officio county highway engineer when the court appoints no regular county highway engineer.

In the counties not operating under township organization, the county is divided into road districts of not less than 9 miles or more than one municipal township in area and the county court appoints a road overseer for each district. These overseers are responsible to the county highway engineer.

Out of 114 counties in the State 22 have adopted township organization, under which the township officers handle the road work and appoint their own overseers. At the head of the township organization is the township board, consisting of a trustee and two other members. There is also an assessor and collector, justice of the peace and constable. Each road overseer in a township organization has a district in the township.

County and township road and bridge funds are derived from a tax of not less than 10 nor more than 20 cents on each $100 of assessed valuation and from a poll tax of $4 payable in cash or labor.

Special road district may be authorized by the county courts. The affairs of such districts are administered by a board selected by joint action of the county court and the municipal council of the town, required to be in each district so authorized. This board may levy taxes, issue bonds, enter into contracts, etc., and perform the various functions connected with road improvement and maintenance in about the same manner as the county and township organization.

Road Bond Laws

No State bonds have been issued for road purposes, but the legislature of 1919 submitted to the people at the election in

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November, 1920, an amendment to the constitution permitting a $60,000,000 issue for State roads.

When petitioned by 200 taxpaying citizens, the county court of any county may submit to a vote the question of issuing bonds for road and bridge purposes. A two-thirds majority vote of those voting is required to authorize the issue. The bonds shall be coupon bonds and issued in such amount as will not, with the existing indebtedness of the county, exceed 10 per cent of the assessed valuation of the taxable property; bear not to exceed 5 per cent interest, be exempt from taxation, and mature within 20 years upon call. The principal, sinking fund and interest of these bonds are paid by a tax levied for this purpose.

Special road districts may be organized and the board of commissioners thereof, and the county court on behalf of the township, may call an election to determine whether bonds shall be issued for road purposes. A two-thirds majority of those voting is necessary to authorize the issuance. These bonds bear not exceeding 6 per cent interest, become due in not exceeding 15 annual instalments, the first of which shall become due not later than two years after the date of the bonds.

In 1919, up to October 1, a total of $15,562,000 of county and district bonds had been voted, $13,300,000 were voted down, and $18,500,000 were proposed to be voted on by other counties and districts.

Convict Labor Laws

The State prison board may cause inmates of the State penitentiary to work on State highways and on request of the various county courts may detail convicts to work on county roads. All expense incurred in connection with the transportation, guarding, and subsistence of such prisoners, and the supplying of proper equipment therefor is paid from State funds.

Automobile Registration

The law provides for annual registration with the Secretary of State. The rates for motorcycles, pleasure and commercial cars and trucks are as follows: Less than 12 horsepower, $4; 12 to 23 horsepower, $6; 24 to 35 horsepower, $10; 36 to 47 horsepower, $14; 48 to 59 horsepower, $16; 60 to 71 horsepower, $20; 72 horsepower and over, $24; electrics, $6.

Road Funds

Funds derived from automobile registration fees, the sale of option stamp, corporation tax fees, etc., which constitute the State road fund are paid into the general treasury of the State,

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but must be appropriated by the legislature before they can be expended.

For the calendar years 1919 and 1920, the legislature appropriated the sum of $4,500,000 to meet the Federal-aid funds allotted the State. This sum, combined with Federal money, is first appropriated among the counties at the rate of $1,200 per mile for construction of the State road system. The remainder may be expended on the State highway system, provided the county, district, or township interested will provide a fund of equal amount, or the remainder of the fund or any part thereof may be expended on the construction of post routes, the cost being borne 50 per cent from the State fund, composed of State and Federal funds or from Federal funds alone, and 50 per cent borne locally.

The sum of $400,000 has been provided for the two-year period to defray the expense of dragging the intercounty seat highway system.

For the same period, $320,000 has been appropriated for the support of the State highway department. Of this amount $20,000 may be expended for the equipment and transportation of convict labor camps and convict laborers.

Progress Report

With over $15,000,000 in road bonds issued in the various counties of the State, applications for State and Federal aid in the construction of the two State roads authorized in each county by the new road law are increasing rapidly.

The State highway board October 1, approved thirteen applications for the building of 160 miles of gravel and concrete road at a total estimated cost of $1,940,027.06. This makes 415.50 miles that have been approved by the board since the new law went into effect, March 17, 1919, to be constructed at a total cost of over $6,000,000. With the exception of two projects, all these roads are to be built of gravel, concrete, brick, or other durable types.

State Highway Officials

State highway board: E. L. Sanford, chairman; Geo. E. McIninch, vice chairman; C. O. Raine, member; Roy F. Britton, member; John M. Malang, State highway superintendent and secretary; Chas. U. Becker, chief clerk.

Engineering department: Alexander W. Graham, State highway engineer; J. Russell Ellis, first assistant engineer; Kirk McFarland, second assistant engineer; Chester D. Mann, bridge engineer; Carl W. Brown, chief of surveys and plans.

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Division engineers: H. D. Judson, St. Joseph; M. J. Hanick, Macon; S. M. Rudder, Sedalia; H. D. Griffith, De Sota; H. P. Moberly, Springfield; M. S. Murray, Sikeston.

Headquarters: Jefferson City, Mo.

Revised by Chas. U. Becker, chief clerk, State Highway Department.

MONTANA

State Aid Legislation

Under an act of the legislature passed in 1917, the governor was required to appoint a non-salaried State highway commission of twelve members of whom not more than six were to belong to the same political party. Three members are appointed each year for a term of four years. One member is appointed from each of the twelve highway districts into which the State is divided for this purpose. The commission handles questions of policy while the executive committee, composed of three members of the commission, acts for it in an executive capacity and holds meetings for this purpose the first Monday in each month.

The construction and maintenance of State highways, which at present embraces about 2,400 miles, is under the direction of the commission. The cost of construction of these roads is borne by Federal, State and local funds. Counties are required to pay 50 per cent of the cost of construction. The commission, on recommendation of the county commissioner, selects the roads deemed of sufficient importance to entitle them to State aid, which are then termed "State highways." The commission, in coöperation with the county commissioners, may divide the roads into two classes, one of primary importance and the other of secondary importance, the primary roads to be the first improved.

Boards of county commissioners are required to make the necessary specifications, plans, surveys and estimates in accordance with the rules and regulations of the State highway commission, which is authorized to approve or disapprove them. The county commissioners may, for such work, employ a competent civil engineer at not to exceed $12 per day. All contracts for State highways are let by the executive committee of the State highway commission.

County commissioners are required to make a report on or before December 30 of each year to the commission, showing in detail all money expended by the county during the current year in the construction and maintenance of all public roads, one part to deal with State highways and the other portion with all other roads.

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The commission is given full power, by the legislature, to do all things necessary to fully carry out the coöperation contemplated and provided for by the Federal-aid road act.

Local Legislation

Jurisdiction over local roads vests in boards of county commissioners consisting of three members, one of whom is elected in each county for a term of six years. They divide the counties into districts and appoint one or more overseers in each. Special bridge and road districts may be created by election.

Road taxes, not less than 2 mills nor more than 5 mills for each county, are levied and collected by the county boards.

Bond Legislation

The legislature, which was in session early in 1919, passed a bill submitting a $15,000,000 State road bond issue to the people for their ratification or rejection at the general election in 1920.

County commissioners may issue bonds for the improvement of State or main highways, but no indebtedness can be incurred in excess of $10,000, unless authorized by a majority of the electors. The indebtedness of the county is limited to 5 per cent of the assessed valuation. Bonds issued for a road improvement district must be paid in 10 years from the date of issue.

Automobile Registration

Automobiles are registered annually with the Secretary of State. The schedule of fees is as follows: Motor vehicles other than motor trucks, up to 23 h. p., $5; from 23 to 50 h. p., $10; over 50 h. p., $15; motor trucks not over 1-ton capacity, $5; over 1 ton and less than 2 tons, $15; over 2 tons and not over 3 tons, $25; over 3 tons, $40.

Road Funds

The State highway fund is derived from the moneys collected by the Secretary of State for motor vehicle licenses. Seventy-five per cent of all the fees thus collected are credited by the State treasurer to the State highway fund, while 25 per cent of the amount collected is returned to the counties from which it was collected, where it is placed to the credit of the general road fund. Two-thirds of the amount credited to the State highway fund is expended at the discretion of the executive committee of the State highway commission. The remaining one-third is apportioned among the several counties in accordance with such miles of road as may be adopted by the State highway commission. The gross

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receipts from the motor vehicle fund during 1918 amounted to 537,000, of which $480,000 was expended on roads.

The commission is not allowed to spend these funds within the corporate limits of the cities or towns or in any of the counties in which the commissioners have failed to provide an amount equal to that set aside by the commission. If any county, within 90 days, fails to avail itself of State aid, the commission may apportion its allotment among the other counties. The regular road fund of the several counties of the State aggregate approximately $4,000,000 per annum.

Progress Report

During 1918 road work was generally suspended, due largely to war conditions. During 1919 a comprehensive highway improvement movement was inaugurated. As a result of this movement, 35 counties have voted highway improvement bonds aggregating in excess $6,000,000, and a fund was thereby created to meet the funds appropriated by the Federal government.

During 1919 over 100 miles of gravel roads had been placed under contract, in addition to a large mileage of earth-road grading. A number of important bridges were constructed and surveys completed for an extensive road program for 1920.

State Highway Officials

State Highway Commission.—Frank Conley, president; Hugh R. Wells, vice president; A. W. Mahon, secretary; A. B. Gibson, C. H. Buford, Jas. T. Finlen, C. W. Morrison, Samuel Webb, Addison M. Sterling, H. A. Templeton, E. A. Richardson, T. F. Hagen, John N. Edy, chief engineer. The first three members named constitute the executive committee.

Approved by Jno. N. Edy, chief engineer, State highway commission.

NEBRASKA

State Aid Legislation

Previous to 1919 all construction work to which the State contributed money aid, including highways and bridges, was carried on under the direction of the State board of irrigation, highways and drainage. The legislature of 1919 reorganized the executive department of the State and established six departments, each of which is presided over by a secretary. The work previously carried on by the board of irrigation, highways and drainage is now under the jurisdiction of the department of public works, under the direction of a secretary, who is appointed by the governor for

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a term of two years, and who receives a salary of $5,000 per year.

The legislature of 1919 also established a system of State highways, comprising 98 routes and approximately 4,500 miles, to be improved and maintained by the department of public works. The cost of construction will be paid from the State highway fund, each county receiving from that fund all money paid into it by the county. State and Federal funds may be combined in the construction of State highways. The maintenance of State highways will be carried on by the counties under the direction of the department of public works, the cost being paid from the State highway fund apportioned to the counties.

The State also aids the counties in the construction of bridges across streams 175 feet or more in width to the extent of paying one-half the cost, but not in excess of the amount appropriated by the State for this purpose. Such bridges are built under the joint supervision of the counties and the department of public works. The cost of maintenance is paid equally by the State and the counties if in excess of $100 per bridge per annum, otherwise the bridge is maintained by the county.

Federal-aid projects must be approved by the county board of the county in which the project is located before it can be submitted by the State to the U. S. Secretary of Agriculture for final approval.

Project districts, each containing not over five counties, have been established, and all State and Federal funds in each district will be considered as a unit for such district and will be available for expenditure on a single project each year. By this arrangement it will not be necessary to build a road in each county each year to take up the State's allotment of funds, but it is planned to build a road in each county during the five-year period covered by the Federal-aid act.

Nebraska's share of the first Federal-aid appropriation from 1917 to 1921, inclusive, is $1,600,000. The legislature in April, 1917, accepted all of the provisions of the Federal-aid law and appropriated $640,000 for the bi-annum of 1917-18 and authorized the State board of irrigation, highways and drainage to coöperate with the county officials and lay out a system of roads which was to be presented to the Department of Agriculture before Federal money could be received.

The State highway department and county officials selected main routes between county seats. This system of roads was presented to the U. S. Secretary of Agriculture and approved and presented to the road committees of the 1919 session of the legislature, which passed a law designating this highway system by

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statute. While the legislature was in session Congress appropriated an additional $200,000,000 of Federal aid, bringing Nebraska's total apportionment to $5,866,303.82. The legislature then made an appropriation of $3,093,262, leaving a balance of $2,133,041.82 to be taken care of by the legislature in 1921.

Local Road Legislation

Local road work in some counties is carried on under the board of county commissioners who divide the county into districts, in each of which an overseer is elected annually. He operates under the immediate direction of a county highway commissioner, who is appointed annually by the board of commissioners. Other counties are divided into seven districts in each of which the electors choose a road supervisor.

In addition to their regular duties, the county road officials are required to adequately maintain that portion of the State highway system lying within their county in accordance with instructions furnished by the department of public works. When a county satisfactorily maintains the State highway within its limits, a sum is paid to the county treasury out of the State highway fund equal to the actual cost of such maintenance, plus an allowance for the use of county machinery agreed upon in advance by the county board and the department of public works.

Local road and bridge taxes are levied by county commissioners or boards of supervisors. The road tax must not exceed 5, and the bridge tax 4 mills. The proceeds from 25 per cent of the net receipts from the registration and licensing of automobiles are used for maintenance. All road taxes must be paid in cash.

Bond Legislation

Any township, county or precinct desiring to issue bonds or to make a special levy to construct or aid in construction of a highway may proceed to vote upon question or make a special levy not to exceed 5 mills for such purpose.

Any county, township, precinct, city or village may issue bonds to consruct a highway bridge across any boundary river of the State, on an affirmative vote of three-fifths of the voters at a special election. The amount of bonds must not exceed 10 per cent of the valuation. In any county, township, precinct, city or village which has made donations to railroads or other internal improvements, a two-thirds vote shall be required for issuing such bonds. The interest shall not exceed 7 per cent. An annual tax is levied for interest and sinking fund. The term of the bond is not designated.

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Similar provisions are made for purchasing private bridges within any township or across any river bounding a township. Any county or city in the State is authorized to issue bonds for internal improvement and it appears that such improvements include highways.

Convict Labor Laws

The department of public works may enter into contract with State institutions for the employment of convict labor.

Automobile Registration

Annual registration fees are $5 for motorcycle, $10 for automobiles for first 2,000 lbs., 50 cents additional for each 100 lbs. in weight of such cars. For trucks and for cars equipped to carry more than seven passengers, the amount of fee is based upon the weight of trucks and cars when loaded to capacity, each passenger being rated at 150 lbs. All registration fees are paid to the county treasurer of the county in which the applicant resides. The county treasurer credits 25 per cent of all fees collected to the road dragging fund of the county, and the rest is transmited to the State treasury and placed to the credit of the State highway fund. Each county shall receive its benefit of all money paid into this fund.

Road Funds

At present, there are three sources from which the State derives revenue for State road and bridge purposes. First, a tax of 3 mills on the dollar on all assessable property in the State. Second, a one-fifth of a mill tax on the dollar, which produces what is known as the State-aid bridge fund; and third, three-fourths of the net receipts from the automobile registration fee.

The 3-mill levy is expected to yield in the neighborhood of $1,600,000 per year. Anticipating this amount, the legislature appropriated for each of the years 1919 and 1920, the sum of $1,546,631,000. This money is apportioned to the various counties on the basis of area, population and mileage of post roads, each having a weight of one-third, and is being used in matching Federal aid on a 50-50 basis.

The one-fifth of a mill tax will yield approximately $110,000 per annum. The proceeds from this tax will be used as far as it goes in paying one-half of the cost of construction and maintenance of certain State-aid bridge projects.

Three-fourths of the net receipts from the automobile license fee, all but 5 per cent of which is apportioned to the counties on the same basis as collected, will amount to about $2,000,000 in 1920, to be used in the same manner as the 3-mill State-wide tax.

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The 5 per cent is used for the maintenance of the department of public works.

Progress Report

Up to October 1, 1919, project statements had been sent to the Secretary of Agriculture for Federal aid on the construction of 2,240 miles of the State system.

In locating and building a system of State highways, a large number of hindrances have been encountered and considerable time required to perfect an organization that would efficiently take care of the vast amount of work entailed, but notwithstanding, the work is progressing according to the proposed schedule and a fair portion of the work started is well on the way to completion. Before October 1, 700 miles of work had been contracted at an aggregate cost of $2,500,000 and a good portion of this mileage was completed by the close of the 1919 season. Surveys were made on approximately 1,500 miles of roads in 1919 and the balance is expected to be in shape so that this work can all be contracted before April 1, 1920. In order to use the first appropriations of Federal money before they elapse, it will be necessary to have $6,500,000 worth of work contracted by June 30, 1920. Before the close of this season, there will have been contracted 212 miles more work, making a total of 912 miles under contract. Included in these contracts will be 17 miles of brick paving in Douglas county and one mile of concrete paving in Butler county. The balance of the work is either plain earth road or graveled surface.

Nebraska's share of the surplus war equipment allotted to the various states will be used in the construction of roads where Federal money is being expended or for the maintenance of Federal aid roads. This equipment is being sent out over the State where it can be used to best advantage in construction work.

Principal Officers of the Department of Public Works

Samuel R. McNelvie, governor; Geo. E. Johnson, Sec'y and State engineer. Bureau of Irrigation, Robert H. Willis; Bureau of Highways and Bridges, E. H. Morey; Chief of Construction, A. S. Mirick; Chief of Equipment, A. H. Moffitt. Division Engineers—Division I, E. F. Bridges; Division II, R. O. Green; Division III, M. F. Black; Division IV, R. L. Cochran; Division V, J. S. McLean. Motor Vehicle Department, Mable Tracey; Chief Draftsman, Geo. K. Leonard.

Headquarters—Lincoln, Hastings, Norfolk, North Platte, and Scottsbluff.

Revised by Geo. E. Johnson, secretary, Department of Public Works.

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NEVADA

State Aid Legislation

In 1917 the legislature passed an act which provided for the creation of a State highway department consisting of a board of directors of three members, who have authority to appoint the State highway engineer and such other assistant engineers and employees as may be necessary. The act also designated a system of State highways comprising four separate routes. The legislature of 1919 established two additional routes making a total of about 2,000 miles of State highways to which State and local funds are applied.

The 1917 legislature made an appropriation of $40,000 to begin the work and levied a seven-tenths mill tax on each $100 of assessed valuation for the Sate and a similar tax for the counties in which the State system is located. This tax was to be increased to 1 mill in each case for all succeeding years. The proceeds from the 1-mill State tax constitute the State highway fund to be expended solely under the jurisdiction of the State highway department and the 1-mill county fund constitutes the county State highway fund to be expended on the State system in each county in which any portion of the State system is located and under the direction of the State highway department through bills approved by the county boards of commissioners in the respective counties.

The 1917 act accepts and assents to the provisions of the Federal-aid act and gives the board of directors full power to secure and make use of the state's allotment of Federal aid. Federal aid allotted to November 1916-21 inclusive, amounts to approximately $4,813,000 to which should be added $152,000 allotted under section 8 of the same act, making a total of about $4,965,000. All State highway projects thus far undertaken, 24 in number, have included Federal aid. The Federal aid on these, up to the present time, amounts to $739,411.

Local Legislation

Local roads are under the jurisdiction of the boards of county commissioners of from three to five in each county. Commissioners divide the counties into districts and appoint one or more overseers for each. The board may appoint a county road supervisor as its executive official or on petition may appoint a board consisting of from one to three road commissioners for each district. County road taxes may be levied at rates not exceeding one-fourth of one per cent of the valuation. On petition a special tax

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may be levied at a rate not to exceed 30 cents on the $100 of valuation. A poll tax at the rate of $3 per capita is also levied.

Bond Legislation

The legislature of 1919 authorizes a State bond issue of $1,000,000 for State roads and to meet Federal aid. The interest and principal on these bonds are to be taken care of by the receipts from automobile fees. The legislature also authorized county bond issues as follows: Humbolt County, $75,000; Pershing County, $75,000; Washoe County, $650,000; White Pine County, $150,000; Churchill County, $100,000; Clark County, $75,000; Elke County, $150,000; Mineral County, $30,000; Esmeralda County, $15,000; Lyon County, $50,000; Douglas County, $150,000. Total $1,520,000. These bonds are authorized in order to permit the counties to take advantage of the Federal aid as the State funds are not sufficient for that purpose.

On a majority vote of the electors of any county, the board of county commissioners may issue bonds for road and bridge purposes. The amount of these bonds must not exceed 3 per cent of the assessed valuation of the real and personal property in the county, and bear not exceed 6 per cent interest. An annual tax is levied by the county by which to pay the interest and retire the bonds in equal amounts after the third year.

Convict Labor Laws

State prisoners may be employed in the construction and maintenance of State highways under the direction of the State highway engineer and the warden of the State prison. The board of prison commissioners has power to pay convicts 25 cents per day for work faithfully performed and to grant time allowance for good behavior. Convicts so detailed are not required to wear stripes. Prisoners under death sentence are not detailed to road work, and no convicts are detailed except with their consent.

Automobile Registration

Automobiles are registered annually with the secretary of State. The passenger cars pay a fee of 35 cents per 100 lbs. for car weight plus 125 lbs. for each passenger, and trucks 35 cents per 100 lbs. including body weight plus load capacity. Manufacturers' or dealers' license fee, $20 each.

The fees are paid into the State treasury to the credit of the State highway bond redemption fund for the purpose of retiring the $1,000,000 State road bond issue, except those received from

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counties not included in the State highway system, which are refunded to the counties and credited to their road repair funds.

Road Funds

State and County Road Funds.—Under the provisions of the State highway law, receipts to the State highway fund amount to approximately $410,000 per year. The county-state highway fund amounts to approximately $375,000 per year. Both these funds are expended under the direct control of the State highway department. The general road and bridge fund of all counties, which is directly under the control of the board of county commissioners of each county, amounts to approximately $400,000 for the entire State.

Progress Report

For the State highway program for the calendar year 1919 there was available approximately $2,000,000 of which about $1,500,000 was expended. By August 1, work on contracts aggregating $600,000 had begun. Additional work was restricted because of prevailing high prices and the general attitude of contractors toward bidding on State work.

State Highway Officials

Board of directors: W. B. Alexander, chairman; George K. Edler, director; James M. Leonard, director; C. C. Cottrell, State highway engineer.

Revised by C. C. Cottrell, State highway engineer.

NEW HAMPSHIRE

State Aid Legislation

In 1915 the legislature abolished the office of State engineer and created a State highway department, in charge of a highway commissioner appointed by the governor for 5 years. He has charge of the location, construction and maintenance of roads built in part or wholly with State funds. All technical features of the work, the award of contracts and the supervision and construction are under his control, but the taking of lands or materials by eminent domain is under the governor and council. Appeals from his decisions may be taken to the governor.

In addition to three original north and south trunk lines there have been designated and laid out 23 cross State roads, and the towns and cities through which these roads pass are entitled to both State aid and trunk line aid. The State contributes toward

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the trunk line work one-half the cost and such further sums in towns unable to pay one-half the cost as the highway commissioner considers equitable. The work is done by contract or by local authorities under the direction of the State highway department. If a city or town neglects or refuses to raise its proportionate part of the cost of construction of a trunk line road within the town, the State may do the work and assess the town for its proportionate part, charging the amount to the State tax of that town. This charge is not to exceed 0.25 to 1 per cent of the town valuation in any one year.

Aside from the trunk line aid the State grants aid to towns on the following plan: Each town, out of the money raised for highway purposes, shall set aside the following amount for the improvement of its highways under the supervision of the State engineer; Towns having a valuation of less than $2,000,000, $1 on each $1,000 valuation; town of $2,000,000 and less than $3,000,000 valuation, 75 cents on each $1,000 valuation; towns of $3,000,000 and less than $5,000,000 valuation, 50 cents on each $1,000 valuation; towns of $5,000,000 and less than $15,000,000 valuation, 33 1/3 cents on each $1,000 valuation; towns from $15,000,000 valuation and upward valuation, 25 cents on each $1,000 valuation; counties in which are located unincorporated towns, $1 on each $1,000 valuation.

If a town desires State aid for permanent improvement in addition to the improvement provided by this method, it must raise an additional amount equal to 50 per cent of this sum before its application for State aid. It will receive for each additional dollar raised the following amounts: Towns having a valuation of less than $100,000, $3 for each $1 so set apart; $100,000 and less than $150,000 $1.25 for each $1; $250,000 and less than $500,000, 60 cents for each $1; $500,000 and less than $1,000,000, 40 cents for each $1; $1,000,000 and less than $3,000,000, 25 cents for each $1; $3,000,000 and upward, 20 cents for each $1. The amounts thus set aside by the towns, respectively, constitute a joint fund for permanent improvement.

The State road funds are provided by direct appropriation and the funds for both trunk line and State aid are met by a current appropriation.

Local Legislation

County commissioners have jurisdiction over roads in unincorporated places and selectmen over town roads. A part of the property road tax is rebated to persons complying with the wide tire laws.

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Automobile Registration

The law provides for annual registration with the commissioner of motor vehicles. The schedule of fees is as follows: Motor cycles, $2; automobiles, 15. h. p. and less $10; 16 to 30 h. p., $15; 31 to 40 h. p., $20; 41 to 50 h. p. $25; 51 to 60 h. p., $30; 61 h. p. and over $40. Motor trucks and automobiles used for carrying passengers for hire on same basis.

The net registration revenue is expended in the maintenance of highways, 35 per cent on State aid roads and 65 per cent on trunk line roads.

Road Funds

There is available $250,000 for trunk line and cross State road construction, to which the towns will contribute a like amount; $125,000 for State aid construction to which the towns will contribute approximately $200,000; and the estimated revenue from the automobile licenses for the year which will be between $400,000 and $500,000, and to which the towns will add a like amount. The fund available for Federal aid is approximately $600,000 and the states portion to meet this $600,000 will come from any of the above appropriations.

Progress Report

During 1918, 86.25 miles of road were improved, comprising 9.15 miles of grading, 5.53 miles of earth, 61.96 miles of gravel, 1.33 miles of crushed gravel, 5.76 miles of macadam, and 2.52 miles of bituminous macadam.

There are 15,116 miles of roads in the State, of which 1255.18 miles have hard surfacing.

The total amount of money available for Federal aid including 1919 is $728,250. This money has been divided into 81 projects. Work has been completed on 13 projects and is now under way on 22. It is expected that at least one-half of these projects will be completed by the end of the present season.

Of the trunk line and cross State roads authorized previous to 1919 comprising a total mileage of 1,205 miles, 899 miles have already been constructed, leaving 306 miles to be built.

State Highway Officials

State Highway Department, Concord.—F. E. Everett, State highway commissioner; C. C. Howe, chief clerk.

Division Engineers.—F. H. Colburn, assistant State engineer; F. W. Brown, Concord; W. A. Grover, Dover; H. L. Smith, Lakeport; C. M. Brooks, Keene; O. M. James, Northwood Narrows; C. P. Riford, Concord.

Approved by F. E. Everett, State highway commissioner.

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NEW JERSEY

State Aid Legislation

A State-aid law was first passed by the legislature in 1891, but did not become operative until 1892, when the first State-aid appropriation of $75,000 was made. Under the original law the administration of the department of public roads was vested in the secretary of the State department of agriculture. In 1894 the State Aid Act was amended to provide for the appointment of a commissioner of public roads to administer the affairs of the department. The legislature of 1899 provided for a State highway engineer to assist the commissioner. This method of administration was followed until 1917. The first State Aid Acts provided that one-third of the cost of construction be paid by the State. This was amended in 1912, allowing the State to pay 40 per cent and providing that plans and specifications be approved by the State commissioner of public roads. This procedure held until 1917.

In 1917, the legislature passed what is known as the Edge Highway Act. Chapter 14 provided for the establishment of a State highway system. This system embraces fifteen routes, includes 660 miles, and is being improved with durable materials. The State has absolute control of construction and maintenance, and will pay the entire cost.

Chapter 15 of the 1917 law established a State Highway Department and provided for the appointment of a State highway commission of 8 members, a State highway engineer, assistant highway engineer, and a secretary. The Governor of the State is ex-officio a member of the commission and is entitled to vote in case of a tie. Two members of the commission must be competent engineers.

Chapter 98 in the 1917 law provided for the appointment of a State engineer, who should act as advisor and supervisor of the State highway department. General Geo. W. Goethals was appointed to this position, and under his supervision the highway department was reorganized and the State highway routes definitely laid out.

The work of the State highway department is divided into four branches.

The Administrative or Fiscal Division is charged with the administration of the department, the certification of all funds, etc.

The Engineering Division is charged with the survey and

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planning of all State highway work and with the checking of plans, etc., prepared by the counties for State-aid work.

The State Labor Division has charge of work performed by State laborers or convicts. There are at present three projects under way with State labor in the State of New Jersey. To date there has been approximately seven (7) miles of concrete pavement completed by these forces. One of the camps is now engaged in constructing a new line over a mountain between Clinton and Phillipsburg by which the grade will be reduced from about 19 per cent to 6 per cent.

The Maintenance Division is charged with the maintenance of State highways that have been taken over by the State highway commission and are now under its jurisdiction.

Local Road Legislation

County roads are under the board of chosen freeholders of the county, which appoints a county road supervisor and a county engineer in charge of roads and bridges. There are about 2,400 miles of county roads in the 21 counties of the State. All other roads not included in the State or State-aid system are constructed and maintained by township authorities.

Road Bond Legislation

No State bonds have been issued for road improvement. Counties and townships are authorized to issue bonds for road and bridge construction. The limit of the indebtedness is 2 per cent of the assessed valuation for counties and 7 per cent for townships. For township bonds a referendum vote is provided for in case taxpayers representing 10 per cent of the assessed value of the property in the townships sign a petition for them. County boards of chosen freeholders may issue bonds without a referendum vote. The terms of all bonds are limited to the probable life of the improvement for which the bonds are issued, as follows: For stone, concrete, and iron bridges, 30 years; for roads built of concrete 6 inches thick or of blocks of any material, or sheet asphalt laid on concrete foundation, 20 years; for water-bound macadam surfaced with bitumen, 10 years; for bituminous concrete construction, 15 years; and for gravel, 5 years. The law also provides that all bonds be paid off by the deferred serial method, the first payment commencing not more than two years from the date of issue.

Convict Labor Laws

The board of chosen freeholders of any county may authorize the sheriff to cause all able-bodied convicts, or as many as may

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be required, to be put to work on the public roads of the county.

The authorities of the State prison may enter into an agreement with the State highway department or other departments of the State government for the employment of prisoners on public work. The State prison labor commission is authorized to acquire land for agricultural and quarry purposes and to transfer prisoners to such lands.

Automobile Registration

Motor vehicles are registered annually with the Assistant Secretary of State, who is ex-officio commissioner of motor vehicles. The schedule of fees is as follows: 10 h.p. and less, $4.50; 11 to 29 h.p., $7.50; 30 h.p. and above, $15; motorcycles, $2; motor trucks having pneumatic tires weighing over 4,000 pounds, in addition to regular fee, $10; dealers and manufacturers, for each car demonstrated, $5; operators, including owners of cars not exceeding 30 h.p., $3; commercial vehicles not equipped with pneumatic tires, except fire engines, steam rollers, traction engines, etc., shall pay fees based on gross weight of the vehicle when loaded to carrying capacity, in accordance with the following schedule: 1,000 pounds or less, $6 per annum; 1,000 to 2,000 pounds, $9; 2,000 to 3,000 pounds, $12; for each 1,000 pounds additional, $2, up to 30,000 pounds, when the fee amounts to $67.

Road Funds

The State road tax of 1 mill on each dollar of assessed valuation provides an income of approximately $3,000,000 per annum, which must be expended for the extension and construction of State highways.

The income from the motor vehicles, licenses, fines, and fees, etc., is appropriated to the State highway department, to be apportioned for the repair and maintenance of roads. The net income from this source for the year of 1919-20 will be approximately $2,850,000, of which amount $2,350,000 is apportioned to the several counties of the State as aid in the repair and maintenance of county roads, and the remaining $500,000 is to be expended for the maintenance of State highways taken over and under the jurisdiction of the State highway department.

The Federal aid apportionment for the year 1919-20 is approximately $1,125,000. This is expended together with State money on the construction of State highways. There is also appropriated by the legislature $500,000 to be used in State aid on new construction, which is apportioned to the several counties of the

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State. The total of all funds available to the State highway department for the fiscal year 1919 is $7,475,000.

All State-aid funds apportioned to counties must be matched dollar for dollar. This means an expenditure during 1919 on State highways and State-aid roads under the direct supervision of the State of a total of $10,325,000, as follows:

State Highway Construction		
State funds	$3,000,000	
Federal funds	1,125,000	
		$4,125,000
Repairs and Maintenance of County Roads		
State funds	$2,350,000	
County funds	2,350,000	
		4,700,000
State Highway Maintenance		500,000
State Aid in New Construction		
State funds	500,000	
County funds	500,000	
		1,000,000
Total of		$10,325,000

Progress Report

Up to January 1, 1919, a total of 2,150 miles of State-aid road had been constructed. There is at present under contract on State highways approximately 100 miles of road which will cost in the neighborhood of $5,400,000. There is also under contract 53 miles of State-aid road which will cost approximately $1,325,000. In addition to the State and State-aid work, there is also a large amount of construction and repairing that is being done by the counties and townships at their own expense.

Highway Officials

The State highway commission, Trenton: John W. Herbert, chairman; George E. Blakeslee, Walter J. Buzby, Samuel Haverstick, Watson G. Clark, Robert S. Parsons, Col. Anthony R. Kuser, L. C. Duncan.

Administrative staff: Wm. G. Thompson, State highway engineer; Edward E. Reed, assistant State highway engineer; A. Lee Grover, chief clerk and secretary to State highway commission.

Revised by A. Lee Grover, chief clerk, State highway commission.

NEW MEXICO

State Aid Legislation

The State highway commission, a bi-partisan continuous body composed of three members appointed by the governor, is at the

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head of the highway department of the State. The State highway engineer, appointed by the commission, is the administrative and executive official in charge of all work under the direction of the commission. Regular meetings of the commission are held on the second Wednesday in January, April, July and October. The compensation allowed each member of the highway commission is $8 per day when actually engaged in official business. The State highway engineer's salary is not fixed by law, except when the State highway engineer is also the State engineer. When such is the case, he is paid $1,000 per annum in addition to his salary as State engineer. The commission is required to construct and maintain at the expense of the State, either in whole or in part, such roads as will best serve the interest of the general public and looking to the construction of a complete system of highways. Funds are provided by a State tax of 4½ mills on each dollar of taxable property in the State.

Local Road Legislation

The 1919 session of the State legislature passed an act creating the office of county road superintendent, who is appointed by the Governor at a salary according to the class of county, from $1,400 to $2,400 per annum. The county road superintendent has full control over all roads in the county except those which are under the control of the State highway commission. Funds for this work are provided by a tax not to exceed 2 mills on each dollar of taxable property in the respective counties.

Local Bond Legislation

When petitioned by not less than 10 per cent of the qualified electors of the county who are taxpayers, the board of county commissioners may submit the question of issuing bonds of the county for road purposes. A majority of those voting is required to authorize the bonds. The amount of the bonds shall not exceed in the aggregate, including existing indebtedness, 4 per cent on the value of the taxable property within the county, shall bear not to exceed 5 per cent interest, and shall run not to exceed thirty years, but may be made redeemable prior to the date of their maturity, as may be provided by order of the commissioners. An additional annual tax levy shall be created to meet the interest charges on the bonds, and there shall be created a fund to be known as the "county highway sinking fund," which shall be used for the redemption of the bonds.

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Convict Labor

Under an agreement between the State highway commission and the board of penitentiary commissioners convicts are used quite extensively on State road work. The State highway commission pays to the penitentiary $1.50 per man per day when he is actually at work. The penitentiary is responsible for the transportation, guarding, feeding, clothing, medical attention and discipline of the convicts, and furnishes all labor on the road grade. The highway department supervises the work of the convicts.

Automobile Registration

The law provides for the registration and licensing with the Secretary of State under the following schedule of fees: Automobiles, 15 h.p. or less, $6, and 40 cents for each additional h. p.; motor trucks, 15 h.p. or less, $7.50, and 50 cents for each additional h.p. The net revenue from licenses goes to the State road fund for expenditure under the direction of the State highway commission.

Road Funds

During each of the years 1919, 1920, and 1921, approximately the following funds will be available for expenditure in the State:

State funds	$1,600,000
County funds	800,000
County bond issue	200,000
State bond issue	2,000,000
Federal fund	1,500,000

The State road fund is derived from all net automobile license fees, receipts from a 4½-mill State-wide tax, and the rest from an excise tax of 2 cents per gallon on gasoline.

Progress Report

During 1917 and 1918 a total of approximately 1,600 miles of road were made, including the installation of 1,200 culverts and the construction of 260 bridges, with total expenditures amounting to approximately $1,500,000.

State Highway Officials

State Highway Commission, Santa Fe, N. M.: President, Charles Springer, Cimarron; secretary, Eugene Kempenich, Peralta; member, W. M. Atkinson, Roswell; State highway engineer, L. A. Gillett, Santa Fe.

Revised by L. A. Gillett, State highway engineer.

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NEW YORK

State Aid Legislation

The State commission of highways consists of a single commissioner who is appointed by the governor, with the consent of the Senate, for a period of 5 years. The commissioner of highways appoints a secretary, an auditor, and three deputy commissioners. Each of the deputy commissioners has had practical experience in the actual building, construction, and maintenance of highways and is familiar with the operations and effect of State statutes relating to highways and bridges.

The first deputy is a practical civil engineer, whose duties relate to the plans, specifications and execution of all contracts awarded by the department. The second deputy's duties relate to the maintenance of State and county highways, and the third deputy's duties relate to the improvement and maintenance of town highways and bridges.

The commissioner has general supervision of highways and bridges, constructed or maintained in whole or in part by the aid of State money; aids district, county, and town superintendents by advice and information; investigates methods of road construction and maintenance; compiles statistics, including a highway map of the State; holds public meetings, etc.

The State is divided by the commission into not more than nine divisions, each in charge of a division engineer who, under the direction of the commission, makes surveys, plans, specifications and estimates for the construction and maintenance of highways in his division constructed wholly or in part by the aid of State money.

All State and county highways on which the State expends money are inspected annually and a report prepared showing their condition, the improvements necessary, and the estimated cost, and a report is made annually to the legislature setting forth the amount required for maintenance for the ensuing year.

The highways of the State are divided into five classes, viz., State highways constructed or improved solely at the expense of the State; county highways improved at the joint expense of the State and county; town highways improved by the towns with State aid; Federal-aid highways built jointly at State and Federal expense; and county roads constructed by the county without State aid. The State and county improved highways are maintained almost entirely at the expense of the State, each town paying toward such maintenance the nominal sum of $50 per mile for each mile or fractional part thereof, of the improved State and county highways within the town boundary. The maintenance

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of town highways is included in the term "construction." The expense of maintaining county roads is a county charge.

The system of State highways embraces 46 routes and includes 3,772 miles, most of which have been improved with hard surfaces. The system of county highways is designated on the map which was approved by the legislature of 1907, and is subject to modification by the board of supervisors of each county. At present there are about 8,558 miles of county highways, about 5,500 miles of which have been surfaced. The cost of improvement of State highways is provided by funds obtained from the sale of State bonds. The State's share of the cost of improvement of county highways is secured from the same source. The balance of the cost of county highways is borne by the county.

The board of supervisors of a county may petition for the improvement of any county highway designated on the approved map. If the State commission of highways approves the request, the division engineer prepares plans and specifications, which are then sent to the county superintendent, and upon his approval thereof they are forwarded to the commission for approval, after which they are submitted to the board of supervisors for final approval and appropriations of the county share of the cost. The commission may then advertise for proposals, award contracts, and carry on the work of improvement. The plans for State highways are prepared by the division engineer, approved by the county superintendent, and finally adopted by the commission, and the work carried on in the same manner as that of county highways.

After the final payment under any contract the State commission files a statement of cost with the county treasurer, who thereupon pays upon the request of the commission the county's share as follows: 2 per cent of the cost to each $1,000 of assessed valuation of real and personal property in the county for each mile of public highway in such county, not to exceed 35 per cent of the cost for the county. The maintenance of State and county highways is under the direct supervision of the commission, which also has authority to provide for a system of patrol of highways, the patrolman to be appointed by the State commissioner of highways.

The State contributes to town highways on the following basis: (1) Where the assessed valuation of the town is less than $5,000 for each mile of highway in the town, outside of incorporated villages, an amount equal to the amount of taxes raised for highways; (2) where the assessed valuation is $5,000 or over and less than $7,000 per mile, an amount equal to 90 per cent of such taxes; (3) where the assessed valuation is $7,000 or over and

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less than $9,000 per mile, an amount equal to 80 per cent of such taxes; (4) $9,000 or over and less than $11,000, 70 per cent; (5) $11,000 or over and less than $13,000, 60 per cent; (6) $13,000 or over, 50 per cent. No town shall receive in one year an average of more than $25 per mile for the total mileage of roads outside of incorporated villages, and the amount which is raised by local taxation shall be such as will, when added to the amount received from the State, be not less than $30 for each mile of highway in the town.

A State bond issue of $50,000,000 was authorized in 1906 and an additional issue of $50,000,000 in 1912. The bond issue was originally intended for the improvement of a system of county highways aggregating 8,380 miles, and to this was added a system of State highways aggregating 3,617 miles of the later bond issue; $20,000,000 is being expended for the construction and improvement of State highways and $30,000,000 for the construction and improvement of county highways. The apportionment among the counties is on the basis of population, the measured mileage of public highways outside of cities and villages, and the total area, each factor having a weight of one-third. Direct appropriations are made by the legislature for maintenance.

Civil Service.—The State commissioner of highways appoints such resident engineers, district superintendents, clerks, officers and employes as may be required, subject to the civil service law and other provisions of law, within the amount appropriated therefor, unless the appointment of such clerks, officers, or employes is otherwise provided for by law.

District superintendents are appointed from lists prepared from examinations which test their qualifications for the actual construction and maintenance of highways and their executive capacity, rather than their scietnific attainments. Clerks, other than those employed in the principal office of the commissioner of highways, inspectors, and other employes in the department, whose duties pertain to the maintenance of highways, are likewise selected from lists prepared from examinations, testing their general knowledge of the highway law and of the practical construction of highways.

Inspectors of construction, other than engineers and levelers, are selected from lists similarly prepared, except that they must be residents of the county in which the highway constructed or improved is located. To the end that the employes of the department of highways engaged in the work of constructing, improving or maintaining highways under the provisions of this chapter may be practical highway builders, the commissioner of highways is authorized to indicate to the civil service commission the relative

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value which should be given to experience and scientific attainments. The commissioner of highways has the power, subject to the provisions of the civil service law, to remove engineers, officers and employes of the department.

Federal Aid.—There has been apportioned to the State, by the Secretary of Agriculture, the sum of $13,688,805.76 from the appropriations of $75,000,000 and $200,000,000 made by Congress.

Local Legislation

New York has a rather centralized system in that the State highway commission, by reason of its extending aid to counties and townships, exercises a limited supervision over practically the entire road mileage of the State. In the counties the governing body is the board of supervisors and in the townships the township board. The county superintendent of roads is appointed by the county board of supervisors, but if they fail to make such an appointment the State highway commission makes it or includes the county in a district and appoints a district superintendent. The term of office of the superintendent is 4 years, but he may be removed by the State highway commission upon written charges. He is subject to the rules and regulations of the commission. The town elect biennially a town superintendent of highways who has supervision of the highways therein, subject to the regulations of the State commission. The State grants aid in the construction and maintenance of practically every type of road in the State and the various road officials conduct their work in accordance with the regulations prescribed by the State highway commission.

Local Bond Legislation

The county board of supervisors may, by resolution, authorize the issuance and sale of bonds for paying the county's share of the cost of any highway. These bonds must not be sold for less than par, and the amount of the issue must not increase the total county indebtedness to more than 10 per cent of the assessed valuation.

For the purpose of purchasing toll roads and bridges, the county board may issue bonds which shall bear interest not exceeding 5 per cent, shall run not longer than 20 years, and shall not be sold below par.

Towns may issue bonds for road purposes when authorized by the county board of supervisors. By a majority vote a town may increase the amount of issue to one-third of its assessed valuation.

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Prison Labor

The superintendent of State prisons may employ the convicts confined in the State prisons in the construction or maintenance of the public highways at any place within the State, outside of any incorporated village or city upon request or with the consent of the commissioner of highways.

An annual appropriation of $50,000 for prison highway construction work has been passed by the legislature for the past few years. The cost of the highway work has been divided between the State and the localities benefited about as follows: the State out of the above appropriation pays the guard, the transportation of the convicts to the job at the beginning of the work and back to prison after its completion, furnishes the bedding and cooking utensils and subsistence for the men, and the locality benefited pays all other expenses, like renting a house, and furnishing a stove, team hire, tools, dynamite and other expenses incidental to the work. In a few cases, where the locality was too poor to pay its share of the expenses, the State has been more liberal in its policy.

When engaged in the maintenance and repair of highways under the jurisdiction of county or town authorities, the locality benefited pays a reasonable compensation, not exceeding $1 a day, for each prisoner.

Automobile Registration

The law provides for annual registration with the secretary of State. The schedule of fees is as follows: passenger cars, 25 h. p. or less, $5; 26 to 34 h. p. $10; 35 to 49 h. p., $15; 50 h. p. and above $25.

Trucks and delivery cars 2 tons or less, $10; 2 to 3 tons, $15; for each additional ton up to 14, $5 per ton; over 14 tons, $70 with $10 for each additional ton in excess of 14 tons. Passenger omnibuses operating wholly in municipality, $10; passenger omnibuses operating outside municipalities $15 to $67.50, according to carrying capacity; dealers and manufacturers, $15; chauffeur's license, $5; motor cycles exempt.

The Secretary of State receives all fees from registrations, fines and forfeitures in the first instance. Fifty per cent of the receipts is turned over to the State treasurer and after appropriation by the legislature is used by the State commission of highways for the repair and maintenance of State and county improved highways. The remaining 50 per cent is distributed among the counties in which the fees were collected, each county thus

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receiving 50 per cent of the total amount of fees paid by residents of that county. The moneys received by a county is used for the permanent construction or improvement of town highways in the county. The city of New York receives 50 per cent of the total amount of fees collected in that city, in the same manner as the counties receive their proportionate share.

Road Funds

Of the $100,000,000 State bond issue authorized in 1906 and 1912, $90,000,000, have been spent or obligated. The total highway expenditure for the State for 1919 is estimated at $20,000,000, of which it is expected that about $3,500,000 was raised by the towns and counties for local road work. The legislature in the early part of 1919 appropriated $17,242,561 for State construction. State aid on county highways, State aid to towns, etc., including the following important items:

Construction of State highways	$4,768,797
From State bond issue for construction of State highways	5,000,000
Aid to town highways	2,150,000
To meet Federal aid	961,573
To meet additional cost of State highway work due to war conditions	3,000,000

Progress Report

During 1918 no contracts were awarded for State and county highways, but 269 miles were completed and officially accepted and 94 miles were completed but not accepted during the year. There were 748 miles of unfinished road under contract on January 1, 1918.

The designated State and county highway systems have a total length of 12,330 miles, of which 8,030 miles are completed or under conract.

State Highway Officials

State commissioner of highways, Frederick S. Greene; first deputy commissioner, Paul Schultze; second deputy commissioner, Irving V. A. Huie; third deputy commissioner, Chas. Van Amberg; auditor, Sephrine D. Gilbert; secretary, R. K. Fuller; assistant secretary, Frank R. Pennock.

Revised by Frederick S. Greene, commissioner.

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NORTH CAROLINA

State Aid Legislation

The State highway commission is composed of four members appointed by the governor, the terms of two appointees being for 2 years, one for 4 years, and one for 6 years, after which the term will be 6 years, thus establishing a continuous commission The chairman of the commission is termed the State highway commissioner and receives a salary not to exceed $5,500 per annum. Other members receive salaries of $10 per day for the time actually employed. The commission employs a State highway engineer and much other assistants as may be necessary. The commission has charge of the construction and maintenance of a selected system of State highways embracing about 3,500 miles connecting the various county seats and other important towns of the State and to which State and Federal funds are applied. The cost of construction of these roads is borne 25 per cent by the State, 25 per cent by the counties, and 50 per cent from the Federal aid appropriation for the State, funds being derived from the revenues accruing from the automobile registration fees.

Local Legislation

Each county is governed by a board of county commissioners of from three to seven members elected usually for a period of 2 years. Thirty-seven counties have five commissioners, one county has six commissioners, one has seven, and one county elects its commissioners for 4-year terms. Except in special cases the county board has charge of the layout, altering, construction, and maintenance of all local roads and bridges and the raising of money therefor.

In carrying out road work in the different counties there is considerable variation in organization and procedure. Many counties in which bonds have been issued have boards of county road commissioners who are given power to employ engineers, or superintendents, and to make contracts, and to buy machinery. In some counties the work is done under the direction of county engineers, in others by county superintendents while in others the work is done by township supervisors. The township supervisors are elected for 2-year terms and have charge of the maintenance of roads and bridges in their respective townships.

There are 25 counties that have county engineers. Such engineers are usually employed by those counties in which extensive improvements are under way, and when the work is being done by contract. In such cases the engineer makes all surveys,

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prepares plans, specifications and estimates, acts as inspector and prepares and approves monthly estimates which are submitted to the county board for payment. County engineers are usually appointed by the county commissioners on the recommendation of the State highway engineer. The county superintendents are usually practical road builders employed in counties where the work is done by force account or with convict gangs. As a rule they are not civil engineers and are, therefore, incapable of making surveys, preparing plans, specifications and estimates.

Bond Legislation

State loans in such amounts as may be necessary to meet Federal aid have been authorized by the legislature, but no such loans have as yet been made. The Legislature of 1917 provided that the State Treasurer should issue State bonds in amounts not to exceed $800,000 per year during the next 41 years, the proceeds to be used as a loan fund to the counties for permanent road improvement. These bonds were to bear 4 per cent interest and the counties benefiting by the act were to annually pay the interest plus 1 per cent on the borrowed money. The additional 1 per cent was to be used by the State for creating a sinking fund with which to retire the bonds after 41 years. Thus far, none of these bonds have been issued.

Counties and townships may issue bonds for road and bridge improvement in amounts not to exceed 10 per cent of the taxable valuation of the property. Before such bonds are issued the question must be submitted to the qualified voters of the county or township and a favorable vote returned by a majority of the voters, but before such election can be held, the State highway engineer must certify that the proposed issue will be sufficient for the purposes set forth in the petition for the election. The term, character and interest rate of the bonds are left to the discretion of the authorities issuing them. In case the bonds are issued, special taxes must be levied in sufficient amounts to pay interest and principal and to maintain the roads constructed. The tax for maintenance shall not be less than 1 per cent nor more than 4 per cent of the bonds issued. A large mileage of the improved roads of North Carolina has thus been financed from bond issues.

Convict Labor

Convict labor may be used by the State highway commission on the State road system, the highway commission paying to the State prison board a price agreed upon by the board and the commission for such labor.

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Automobile Registration

Automobiles are registered annually with the Secretary of State, the fee being as follows: 26 h. p. or less, $10; 26 to 30 h. p., $15; 30 h. p. and over, $20; for passenger cars used for hire, double the amount fixed for like motor vehicles for private use. The fee for motor cycles is $5; for motor trucks of one ton capacity or less, $12.50; 1 to 2 tons, $25; 2 to 3 tons, $40; 3 to 4 tons, $65; 4 to 5½ tons, $100; on each trailer $10 for the first ton carrying capacity and $20 for each additional ton.

Road Funds

The net revenue derived from motor registration fees constitute the funds for the operation of the state highway department, for meeting Federal aid and for aiding counties in construction and maintenance of the State highway system. It is estimated that the fees for 1919 amounted to $1,300,000.

Progress Report

During 1918 the State entered into agreement with the counties and the Federal Government in the building of 200 miles of road costing $800,000, and consisting principally of sand-clay and gravel types.

During 1919, it was estimated that 600 miles of road were built with Federal and State aid in coöperation with counties at a cost of $2,000,000 and consisting principally of sand-clay, gravel, concrete, and bituminous roads.

State Highway Officials

State Highway Commission, Frank Page, Chairman, J. E. Cameron, J. G. Norfleet, and J. G. Stikeleather; State Highway Engineer, W. S. Fallis.

Revised by W. S. Fallis, State highway engineer

NORTH DAKOTA

State Aid Legislation

At the general election on November 3, 1914, an amendment to the constitution was adopted, providing that the State may grant aid in the construction and improvement of public highways.

In 1917, the legislature passed a law creating a State Highway Commission, assenting to the Federal Aid Road Act, etc. The commission is composed of the governor, the commissioner of labor and agriculture, the State engineer, whose duty as such is

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still entirely independent of the State highway department and who is ex-officio chief engineer and secretary of the commission, and two civilian commissioners, appointed by the governor at $10 per day and expenses, salary limited to $600 per annum.

The commission is authorized to lay out a State highway system in conjunction with the several county boards, the system to consist of the main traveled roads in the counties. Changes in the system may be made by the chief engineer with the approval of the commission. At present, the system comprises about 5,000 miles or about 7 per cent of the entire mileage of public highways in the State.

The commission prepares plans and specifications for all State and Federal aid projects, grants aid therefor, awards contracts with the approval of the county boards, directs and supervises the construction work, etc.

In 1919, the existing law was amended in certain respects, the most notable of which are that the commission "shall determine the character and have general control and supervision of the construction and reconstrucion of all bridges, culverts, and other highway structures, and of all other improvements on the system of highways"; that the State directs and supervises the maintenance of the entire system of State highways; that it may purchase right-of-way for gravel pits, etc; that there is placed at the disposal of the commission the laboratories, etc., of the State educational institutions and that the collection, etc., of the automobile registration fees is taken over by the State highway department.

State aid is granted on a 50-50 basis as far as possible. County and State-aid funds are used jointly to secure Federal aid. There are no funds, except those for the operation of the State highway department, independently available for expenditures by the commission. County funds are always involved.

Local Legislation

In counties having no civil township organization the county board of commissioners acts as a highway board; in organized townships the authority is vested in the board of supervisors. In localities where there is unorganized territory the county commissioners may create as many road districts as in their judgment is deemed expedient and may appoint for each district an overseer of highways. At the first meeting of a township board, succeeding the annual town meeting, township overseer is appointed to have direct charge of the construction and maintenance of highways. In unorganized territory the district overseer of highways have the same powers and duties as township over-

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seers of highways in organized townships. In counties having a county superintendent of highways the township road overseer is ex-officio deputy county superintendent of highways for his respective township. A law was passed in 1915 creating a board of highway improvements in each county, consisting of one member from each road district, which is required to formulate plans and methods for the uniform working and establishing of highways within the county. Such methods as they adopt must be followed in each of the districts in the county, but there is no penalty for failure to do so.

Bond Legislation

A State highway bond issue bill for $4,000,000 was introduced in the legislature in 1919 but was withdrawn upon the discovery of its unconstitutionality. Later a concurrent resolution to submit to the people in referendum an amendment to the constitution, making a $50,000,000 bond issue for road purposes possible, was also defeated.

Section 183 of Article 12 of the constitution authorizes counties townships, cities, towns, or other political subdivisions to create an indebtedness not to exceed 5 per cent of the assessed valuation of the taxable property, but apparently there has been no general statutory enactment permitting the creation of an indebtedness for road purposes under authority thus conferred.

Convict Labor Laws

The State law provides that inmates of the State penitentiary may be used upon the public highways. No convict labor has ever been used, for the reason that all of the convicts are needed to keep the regular industries of the penitentiary in operation.

Automobile Registration

The State highway department has control of the registration of motor vehicles. The 1919 law provides that the fee shall be paid on the basis of horsepower, weight, and factory selling price; as follows: 5 mills per dollar of selling price plus; 20 cents per 100 lbs., or major fraction thereof for the net weight of the vehicle, and 10 cents per h. p. A reduction of 10 per cent over these rates is allowed for the second year, a 25 per cent reduction for the third year, and thereafter a 40 per cent reduction, provided that the fee shall at no time be less than $5 per car.

Road Funds

Funds expended by the State highway commission are derived from the automobile fees, of which not more than $150,000 an-

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nually may be used by the commission for administration, engineering and general operation, including cost of collection of the fees.

One-half of the remainder is returned to the country treasuries and is known as the "Special Road Maintenance Fund, to be expended under the direction of the commission, primarily for the maintenance of the State highway system. The remaining one-half is known as the "State-aid fund," 90 per cent of which is credited in the State treasury and must be spent in the several counties on construction, in the same proportion as that in which the fees are collected, except that, if any county has unused State credit in excess of $3,000 or in amount greater than its accumulated credit for three years, the commission may direct the county to proceed to utilize it, and on its failure to do so the commission may use the amount at its discretion. The remaining 10 per cent is expended by the commission at its discretion.

County road and bridge levies amount to about $1,500,000 annually, expended independently of State and Federal aid. Town levies amount also to about $1,500,000 annually. State aid available aggregates about $250,000 annually while total Federal aid for the State is $4,226,000, all of which it is expected will be covered by Sate and local funds.

In addition to funds secured by automobile and motor cycle licenses, the local highway maintenance funds are secured by means of a poll tax of $1.50 and a property tax of not to exceed 5 mills for highways. In each county having a population of 2,000 or more, there is levied a property tax of not less than 0.25 mill nor more than 4 mills, which is kept in a distinct fund known as the county road fund and is spent in highway improvement under the direction of the commissioners. This fund is in addition to all other taxes for highway purposes and is expended only in grading ditching, and surfacing the principal county thoroughfares for which the means otherwise provided are not, in the opinion of the county commissioners, sufficient.

The electors of each township have power at their annual meeting to vote to raise such sums of money for the repair and construction of roads and bridges as they shall deem expedient, provided that the amount of tax for road purposes shall not exceed 8 mills on the dollar, and the tax for bridge purposes shall not exceed 2 mills on the dollar.

Progress Report

Most of the work of the State highway department is Federal aid work. About 500 miles of State highway projects have been put under contract since the creation of the commission in March,

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1917, of which only a small part has been entirely completed. About 90 per cent of the projects are earth roads, the remaining 10 per cent being gravel. About 2 miles of concrete road are planned for 1920. Preliminary work is now under way for a wagon bridge to span the Mississippi River at Bismark, estimated to cost $1,000,000 more or less. Work for 1920 will involve from 500 to 1,000 miles of new work at an average of about $3,000 per mile.

State Highway Officials

State Highway Commission: Hon. Lynn J. Frazier, governor, chairman; Hon. John N. Hagan, secretary of labor and agriculture commission; W. H. Robinson, state engineer, secretary; J. J. Marquart, commissioner; Frayne Baker, commissioner.

Department Organization: W. H. Robinson, chief engineer; J. E. Kaulfuss, assistant chief engineer; R. P. V. Marquardsen, bridge engineer; W. W. Moyer, road engineer; H. K. Craig, maintenance engineer; L. O. Marden, chief draftsman; R. E. Schumann, chief clerk; E. P. Crain, registration clerk.

Prepared by J. E. Kaulfuss, assistant chief engineer, September 10, 1919.

OHIO

State Aid Legislation

At the head of the State highway department is a State highway commissioner who is appointed by the governor with the advice and consent of the Senate for a term of 4 years. He must be a competent civil engineer with 5 year's experience and receives a salary of $5,000 per annum. There is also a nonsalaried bipartisan advisory board consisting of four members appointed by the Governor for terms of 4 years, one being appointed each year. All official acts of the State highway commissioner in connection with the designation of intercounty or main market roads, the granting of aid, the letting of contracts, the purchase of materials, etc., the entering into agreement with the Federal Government on post road projects, and the designation of engineers other than county surveyors to take charge of road and bridge work within any county under control of the State must have the approval of the advisory board. The State highway commissioner is ex-officio secretary of the advisory board.

The State highway department has general supervision over the construction and maintenance of State roads, inter-county highways, and main market roads, and must approve plans,

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specifications and estimates for all other road, culvert and bridge work on request.

The engineering work of the department is conducted under the direction of three deputies appointed by the commissioner. These deputies have charge of construction, maintenance and bridge work. Each deputy receives $3,300 per annum. Acting under the three deputies, there are nine division engineers appointed by the commissioner from the civil service eligible list. The county surveyor of the various counties are, by virtue of their positions, resident engineers of the State highway department. If any county surveyor fails to comply with the requests of the State highway department, he may be removed as representative of the State and a resident engineer appointed. If county surveyors act for the State, one-fifth of their salary is paid from the State highway fund.

There are 492 intercounty highways in the State embracing 9,889 miles, forming a continuous State system. These roads were selected by the highway department and were legally adopted by the governor's approval in December, 1912. From this system the legislature in 1913 designated 12 main market roads. This number has since been increased by the State highway commissioner, with the approval of the governor, to 22, and includes about 3,000 miles of the inter-county highway system.

Applications for State aid on intercounty highways or main market roads originate with the county commissioners or township trustees. Contracts are let by the State with the approval of the county commissioners. If counties or townships do not make application for aid, the State highway department may proceed with the work without local initiative and pay the whole cost of construction except 10 per cent, which is assessed against the abutting property owners.

When the State is coöperating with a county, the percentage of cost paid by the State, county, township and property owners are as follows: State, not to exceed 50 per cent; county, 25 per cent; township, 15 per cent; and property owners, 10 per cent. The State may pay less than 50 per cent, the balance being made up by the county. When the tax duplicate (assessed valuation) of a county is less than $30,000,000, but not under $22,000,000, the State may pay not over 75 per cent. When it is less than $22,000,000, the State may pay 90 per cent. The county may assume the township's share or the township may assume the county's share.

Under all conditions the property owners are required to pay not less than 10 per cent of the total cost, but they may be assessed in an amount above this at the will of the county

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commissioners. The assessment may be made on a front-footage basis by unanimous vote of the county commissioners on property within one-half mile of the road. No part of the cost of bridges and culverts is assessed against the township or property owners, the cost being paid by the State and county in the same ratio as for road construction. State roads may be maintained by the State at State expense under the immediate direction of the county surveyor, but a portion of the cost of maintenance may be paid by the counties or townships.

All Federal money is being applied to the 12 main market roads of the State, principally in connecting up the missing gaps in order to complete the system.

Local Legislation

County roads include all roads not State roads but which have been or may be surfaced under the direction of the county surveyor with hard materials to a standard fixed by the county commissioners. All other roads are under the jurisdiction of township trustees, who act under the general supervision of the county surveyor.

County commissioners may levy not to exceed 2 mills on the dollar on all property, including that in cities and villages, for maintenance of county roads and bridges, or a sufficient amount to produce at least $100 for each mile of county roads. An additional levy of 1½ mills may be made to pay the county's portion of State roads. County roads may be improved under the local assessment plan on petition of 51 per cent of the abutting land owners, and the whole or a portion of the cost may be assessed against land owners within 2 miles of the road in proportion to benefits, or a portion of the cost not to exceed 50 per cent may be paid by the county or township. A special levy may be made by the county commissioners against the township for this purpose not exceeding 3 mills. Township road funds are derived from a tax of 3 mills levied by the township trustees. Two additional mills may be levied to meet the township's portion of the cost of State roads. Township roads may also be improved under the local assessment plan on petition of owners, in which case from 25 to 50 per cent of the cost may be levied against abutting property within 1½ miles on either side or termini of the road.

Bond Legislation

In anticipation of the collection of taxes or assessments to meet the county's or township's share of State roads or county roads built under local assessment plan, the county commissioner may

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issue sinking fund bonds maturing in not to exceed 10 years and bearing not to exceed 5 per cent interest. The aggregate amount of such bonds for State roads must not exceed 1 per cent of the assessed valuation.

For the construction of township roads, the township trustees may issue bonds maturing in not more than 10 years and bearing not to exceed 6 per cent interest, upon the approval of a majority of the electors. The amount to be issued is left to the judgment of the township trustees.

Convict Labor Laws

State convicts may be used by the highway department through requisition on the State prison authorities in improving intercounty or main market roads, or in preparing materials therefor. The cost of transportation, guarding, clothing, and other expenses incident to such work may be paid by the State highway department from funds available for the construction of State roads.

Automobile Registration

Automobiles are registered with the Secretary of State, the annual fee being $5 on each car except electrics, which pay $3. The registration fee for trucks is the same as that for passenger cars, but a separate record is kept. The net receipts from this fund are used for the repair and maintenance of State roads.

Road Funds

The following appropriations were made available July 1, 1919: Intercounty highway for 2 fiscal years beginning July 1, 1919, $6,466,500; main market roads for 2 fiscal years beginning July 1, 1919, $2,225,500; for maintenance and repairs for the fiscal year beginning July 1, 1919, $2,250,000. The total Federal-aid allotment for Ohio for the fiscal years 1917 to 1920, inclusive, amount to $3,523,478.70.

The Intercounty highway and main market funds are appropriated from funds derived from taxation by a levy of 5/10 of 1 mill upon all the taxable property of the State. The maintenance and repair fund is appropriated from the net funds derived from automobile license fees.

The intercounty highway fund is used for the construction, improvement, maintenance and repair of the intercounty highways and must be expended so as to produce an equal division among the 88 counties of the State of the moneys so appropriated by the General Assembly for each 2-year period.

The main market fund is used on the main market roads of the State and is so expended as to distribute equitably, as far as

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practicable, the benefits to the different sections and counties of the State.

The maintenance and repair fund is used for the maintenance and repair of both the intercounty highways and main market roads. A part of this fund may be used to establish a system of patrol or gang maintenance on these roads.

Progress Report

From January 1 to December 31, 1918:		
Total expended on roads, bridges and culverts		$6,327,397.77
Of this amount the State paid	$2,801,747.52	
And the counties paid	3,525,650.25	
Miles completed and opened to traffic		342.03
New contracts let		139.87
Uncompleted contracts let prior to January 1st, 1918		233.82
Total mileage under supervision		715.72

Status of Federal Aid

Federal Funds		
Credits		
July 1, 1917		$ 186,905.42
January 1, 1917		373,810.84
January 1, 1919, appropriation ending June 30, 1919		558,043.42
January 1, 1919, appropriation ending June 30, 1920		741,784.99
March 7, 1919, extra funds for 1919		1,854,462.47
March 25, 1919, appropriation for 1920		2,781,693.71
Total		$6,496,700.85
Projects to which numbers have been assigned	$5,480,883.36	
Projects to which numbers have not been assigned	991,160.00	6,472,043.36
Total balance available to July 1, 1920		$ 24,657.49

Average proportion paid by government .....33 per cent
Average proportion paid by counties.....67 per cent

State Highway Commissioner, A. R. Taylor.
Deputy Highway Commissioner, construction, H. D. Bruning.
Deputy Highway Commissioner, bridges and culverts, John R. Chamberlain.
Deputy Highway Commissioner, maintenance and repair, A. H. Hinkle.
Secretary, W. E. Martin.
Headquarters, Columbus, Ohio.
Revised by A. R. Taylor, State Highway Commissioner.

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OKLAHOMA

State Aid Legislation

The State department of highways is under the charge of the State commissioner of highways, who is appointed by the Governor for an unlimited term. He is required to furnish, without charge, to any road official standard plans and specifications for roads and bridges, to report on plans and specifications submitted by any road official, to compile statistics of the roads in the State, to establish in each county standards for the construction and maintenance of its roads and bridges and to advise with State and municipal authorities on water and sewerage projects. With the consent of the Governor, he appoints a State engineer, an assistant State engineer and other assistants.

The board of county commissioners select not less than 10 nor more than 15 per cent of the total mileage of roads connecting principal market points in the county and joining similar roads in adjacent counties to serve as State roads, and such portions of the designated roads as are approved by the State commissioner of highways are adopted as State roads. If any county fails to designate such a road system the commissioner of highways has power to make the designation. These roads are improved at the joint expense of the State and counties under the direction of the State commissioner. The surveys and plans are prepared by the county engineers. All bridges and culverts must be permanent and approved by the department of highways.

Federal Aid.—In 1917 the legislature authorized the State highway department to conduct all negotiations with the U. S. Department of Agriculture as to Federal-aid projects and to spend all funds provided by the State or its subdivisions to offset such Federal-aid funds.

The legislature of 1919 was unable, owing to the increased cost of maintaining the State government and institutions and the high price of material used in continuation of the general building program of the State, to make appropriations to meet Federal aid.

It therefore called an election for a State-wide bond issue of $50,000,000 with which to offset Federal appropriations and to embark on a road-building program, but this issue failed to carry at an election held on May 7, 1919. As it is necessary to amend the constitution of the State before any bond issue can be floated, nothing more could be done until another meeting of the legislature.

It therefore became necessary for Federal aid to be offset by

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funds raised by the counties, and special legislation was passed by which the department of highways and the State treasurer became direct agents for the counties in such relationship. Arrangements have been made to meet all Federal appropriations available for expenditure at the present time.

Local Legislation

The board of county commissioners of each county must appoint a county engineer, who must pass an examination held for the State department of highways by a board composed of three disinterested civil engineers. One person may serve as county engineer for two or more counties.

All roads except State roads are under the township officials. When the State roads of a county are finished township roads of an equal standard of construction may be added to the State system. The road work of each township is under a road superintendent, but the plans and specifications must be furnished by the county engineer.

No draft wagon of 1-ton capacity or more, having metal tires less than 3 inches wide, may be sold in the State under penalty of a fine of from $5 to $25 for each sale.

Bond Legislation

Township boards may issue bonds in an amount not exceeding 5 per cent of the value of the taxable property in the township, upon a three-fifths vote of the electors voting at a special election. The interest cannot exceed 6 per cent and the term must not exceed 25 years. An annual tax must be levied to pay the interest and to create a sinking fund for the redemption of the bonds.

County commissioners are authorized, upon a three-fifths vote of those voting at a special election, to issue county bonds in an amount not greater than 5 per cent of the assessed valuation and for a term not exceeding 25 years for building, or acquiring bridges, or building roads surfaced with gravel, stone or other hard material. An annual tax is levied to meet the interest and sinking fund charges on the bonds. All work done under a bond issue must be performed under an engineer designated by the State highway commissioner.

Convict Labor Laws

State convicts are required to be worked on public highways as continuously as possible. The State board of public affairs furnishes tools, machinery and draft animals. The cost of quarters, food, medical attendance and guards is borne by the prison

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funds. A county using convict labor pays all charges for transportation, feed for animals, board for guards, supplies for machinery excess cost of feeding prisoners above average cost at penitentiary, and materials for construction. The State board of public affairs formulates the regulations for governing the convicts and the State corporation commission establishes the transportation rates for moving them. The State board of public affairs may furnish convicts for county road work under certain restrictions. In 1918 seven crews with a total of 480 convicts were employed on road work.

Automobile Registration

Motor vehicles are registered with the department of highways. The fee is 50 cents per horsepower for the first year, 40 cents for the second year, 30 cents for the third year and 20 cents a year thereafter; dealer's fee, $15; electric vehicles are taxed on ad valorem basis. Nine-tenths of the fees are returned to the counties where cars are owned. The treasurer of each county pays 25 per cent of the fees to first-class or chartered cities where cars are owned within their limits and the remainder is used as a county road maintenance fund for road dragging and for construction of new roads.

The 1919 legislature passed an amendment to the motor vehicle law providing that all motor vehicles should pay a registration fee based on the purchase price of such machine, but that a minimum tax of $10 should be levied on every machine registered. Traction engines owned and operated for agricultural purposes are exempt from the motor vehicle tax, but are placed on the property rolls and taxed on their ad valorem basis. At the time this legislation was passed it was definitely determined that the policy of the State should be to discourage the use of excessively large trucks, and the basis for valuation for taxation purposes for such machines was placed on the rated carrying capacity and the tax was purposely placed so that the rate would be prohibitive on trucks with carrying capacity in excess of 5 tons.

This legislation was to take effect on January 1, 1920, but under the initiative and referendum provisions of the constitution of Oklahoma it was referred to the voters and is inoperative until the decision is made at the next general election in August, 1920.

Road Funds

The State collects a property tax of 0.25 mill, the proceeds forming the State highway construction fund, but used by the counties for State road construction. Receipts from this fund

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amount to about $300,000 annually. Each county may levy a property tax of 0.25 mill or more up to the maximum levy of 8 mills for use on State roads under the board of county commissioners. Any county levying this tax is entitled to receive the money in the State highway construction fund standing to its credit. The townships are authorized to levy a 2-mill tax for road dragging and not over 1½ mills for construction. The ¼-mill tax for State roads has proved inadequate and private subscriptions have been made to enable the work to proceed.

Another source of revenue is a "gross production tax" of .5 per cent of the gross value of asphalt and various designated ores and 3 per cent of the gross value of petroleum and natural gas produced in the State. One-sixth of the returns of this tax is given to the counties where oil or minerals are produced for aid in building permanent bridges and roads with a surface of gravel, rock or other hard material.

In 1917 the legislature appropriated $1,000,000 for each of the fiscal years ending June 30, 1918, and June 30, 1919, for State aid in the building of roads in the counties. The general terms of the appropriation bill and the rules for expenditures were drawn up along the lines of the law and rules for expenditures of Federal-aid funds, but owing to the uncertainty of the appropriations, which were made contingent on the surplus in the general fund of the State treasury, administration of this was unsatisfactory and the results fell far short of the intentions of the legislature and the State highway department.

Progress Report

Since the organization of the highway department in 1915 all work has been hampered by insufficient appropriations and by general conditions arising from the loss of many men to the army, poor transportation and high cost of materials. The department has, however, been able to issue standards for all types of openings from drain tile to standard riveted and pin-connected trusses with spans up to 150 feet and for substructures to meet practically all conditions occurring in a State with topography running from alluval flats to mountain ridges.

Officers of the department of highways have kept in personal touch with construction throughout the State and have improved the standards of work and largely through their efforts in encouraging the construction of permanent openings a great portion of the maintenance expense to the counties, arising from the necessary replacements of frame structures, has been eliminated.

Three counties have issued bonds in large amounts to build permanent roads, and a different type of road has been selected

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in each county. In addition to this, the State has under construction at the present time 11 Federal-aid projects in which are embraced construction of 9 different kinds of road of the higher types. One section of approximately 3 miles built in the immediate vicinity of the State Capitol serves as an object lesson for the benefit of visiting State and county officials.

A large portion of the work undertaken with Federal-aid funds has been the building of bridges across the overflow streams arising in the Rocky Mountains and flowing across the State towards the Mississippi Valley. These streams almost invariably run through the Indian Territory portion of the State, where large parts of the land are non-taxable on account of Indian ownership, and it has heretofore been impossible for local authorities to finance the construction of such bridges.

The expenditures during the war period were naturally curtailed owing to the desire of the State and county officials to comply as fully as possible with the general plans of the council of national defense, but all work done was well done and planned with the idea of permanency and durability. Expenditures during the years 1916, 1917 and 1918 averaged about $6,500,000 per year, secured from township and county levies and from bond issues, and the results, except in the case of township bond issues where it is impossible to prevent expenditures in earth roads of a very low type, have been very satisfactory. Experience has proven the impossibility of maintaining under modern traffic conditions earth or even sand-clay roads in a county where 90-day dry spells are almost annual occurrences, and plans are being formulated calling for surfacing of at least one-third of the State road system.

State Highway Officials

Commissioner of highways, Henry Wood; State engineer, R. C. Terrill; assistant State engineer, J. W. Evans (in charge of sanitary laws).

Headquarters, Oklahoma City.

Revised by Max L. Cunningham, former State engineer.

OREGON

State Aid Legislation

The State highway commission is composed of three members appointed by the governor, one from each congressional district, to hold office for 3 years, one commissioner's term expiring each year. The commissioners are allowed their actual traveling ex-

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penses while on official business, but receive no salary. The office of the commission is in the Capitol building at Salem.

The commission has general supervision over the construction and maintenance of State highways, decides on their definite location, adopts standards of construction, approves specifications and plans, awards contracts, selects materials and decides on types of road and bridge structures. It appoints the State highway engineer, who receives a salary of not more than $5,000 per year, together with actual traveling expenses, and employs such other assistants at such salaries as may be necessary. The State highway commission, the engineer and other employees constitute the State highway department.

The commission is authorized to construct a system of State highways, comprising approximately 4,300 miles, at State and local expense. The roads in the system are maintained under State supervision, the costs being borne equally between the State and counties. It is also empowered to cooperate with the counties and the Federal Government in State highway construction, to purchase or contract for supplies or equipment, or undertake construction work with its own forces. It may condemn rights-of-way across private property and may acquire, by condemnation, titles to land upon which road materials are located.

The highway engineer directs the work of surveys and the preparations of plans, specifications and estimates, and acts in an advisory capacity to county courts. Surveys, plans and estimates for State highways are furnished free to county courts. All construction work done by counties on State highways, to which the State contributes not less than 25 per cent, is subject to the supervision of the State highway department.

Local Road Legislation

Road and bridge affairs in the county are administered by a county court composed of a county judge and two commissioners, each elected for terms of 4 years.

Road Bond Legislation

In 1917 a State bond issue amounting to $6,000,000 was authorized to defray the State's portion of the cost of constructing a system of hard-surfaced highways. These bonds are of the deferred serial type, bear interest at 4 per cent and may run not to exceed 25 years, the first payment to be made at the beginning of the sixth year. In 1917 the legislature also authorized bonds to an amount sufficient to meet Federal aid. These bonds bear 4 per cent interest and mature in from 4 to 8 years.

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In 1919 State bonds amounting to $10,000,000 were authorized, the term, interest and method of retirement being the same as the $6,000,000 issue of 1917.

Road bonds in an amount not to exceed 6 per cent of the assessed valuation of a county may be issued by the county court when authorized by a majority of the voters of the county. The term of such bonds is fixed in the proposal submitted to the voters. The interest may not exceed 6 per cent.

Convict Labor Laws

The State highway commission may authorize and provide for the construction of any State road or part thereof by convict labor. No convicts have been used on road work during the past four years, as there are at present fewer convicts in the penitentiary than at any time during the past 35 years and these are not sufficient to do the work within the walls of the institution.

Upon the written request of the county court of any county, the governor may detail from the State penitentiary such convicts as in his judgment may seem proper for use on the public highways. They are delivered to the county court on such terms and conditions as are prescribed by the parole board and approved by the governor.

Automobile Registration

The following annual license fees are paid to the Secretary of State upon registration of motor vehicles: Motor bicycles, $3; motorcycles, $6; electric pleasure vehicles, $18; electric service vehicles under 1-ton capacity, $25; all steam, gasoline and hydrocarbon-operated vehicles (except motor trucks having a rated maximum load of carrying capacity of 1 ton and over), up to and including 23 h. p., $15; 23 to 26 h. p., $22; 26 to 30 h. p., $28; 30 to 36 h. p., $36; 36 to 40 h. p., $48; 40 h. p. and over, $56; motor trucks and trailers (except motor trucks having a carrying capacity of less than 1 ton), 1 to 1½ tons, $32; 1½ to 2 tons, $48; 2 to 2½ tons, $60; 2½ to 3 tons, $72; 3 to 3½ tons, $84; 3½ to 4 tons, $96; 4 to 4½ tons, $108; 4 to 5 tons, $120. The fee for trailers is one-half the fee for trucks of like capacity.

Road Funds

State Funds.—To provide funds for carrying out State highway work, there is available the ¼-mill tax levied on all assessable property in the State, which amounts to $250,000 annually; a tax of 1 cent per gallon on gasoline and ½ cent per gallon on distillates, which amounts to $400,000 per year; also the fees from the licensing of motor vehicles less the cost of administra-

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tion and less the refund to the counties. In 1919 there was a total of approximately 81,000 automobiles registered. It is estimated that the fees will reach $2,300,000 in 1920, of which 25 per cent is refunded to the counties from which the motor vehicles are registered.

In addition to the above there was available on May 1, 1919, an unexpended balance of $4,560,000 of the $6,000,000 bond fund authorized in 1917; an unexpended balance of $1,419,280.55 in the State cooperative bond issue to meet Federal funds, laws of 1917; and the proceeds from the sale of the $10,000,000 bond issue authorized by the 1919 legislature. State funds expended in counties during 1918 amounted to $2,621,825.11.

Federal Funds.—The good faith of the State is pledged to make available funds to meet the Federal cooperation offered. The total Federal funds allotted to Oregon are as follows: For 1917, $78,687.37; for 1918, $157,374.74; for 1919, $1,521.21, and for 1920, $1,495,938.13. For forest roads within the State the total of Federal funds allotted is as follows: 1917, $127,794; 1918, $127,794; 1919, $346,665, and for 1920, $346,665.

Market Roads.—The laws of 1919, effective 1920, provide for a tax levy of 1 mill on all taxable property of the State for the State highway funds, which will be apportioned by the highway commission to the various counties so that each will receive an amount at least equal to its contribution. Counties desiring to avail themselves of these funds must provide a uniform tax levy to equal the amount apportioned.

Exclusive of State expenditures, it is estimated that the counties spend approximately $5,000,000 annually for roads and bridges, county funds being derived from county taxes which may be levied at rates not exceeding 10 mills on the dollar of valuation.

Progress Report

During the bi-annual period from December 1, 1916, to November 30, 1918, the State highway department completed 50 miles of hard-surfaced roads, 111.8 miles of broken stone and gravel roads, 134.5 miles of graded roads, and built 40 bridges. With the closing of the war and the prospect of declining prices of material and a more plentiful supply of labor, much was accomplished during 1919. The program for the season provided for the improvement of State highways in each county in the State.

The following is a summary of all State highway work under contract September 15, 1919, including all post and forest projects:

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Highway	Paving Miles	Macadam Miles	Grading Miles	Price Bid
Pacific	118.8	44.5	103.7	$4,426,320.75
Columbia River	105.85	69.5	142.4	4,104,079.21
West Side Pacific	49.8	14.6	46.7	1,383,118.30
Salem-Dallas	13.1	.....	13.1	320,742.50
Yamhill-Nestucca	8.0	19.1	17.1	426,682.11
John Day	.....	11.1	31.9	399,913.65
La Grande-Enterprise	.....	.....	9.6	42,370.00
Portland-Forest Grove-McMinnville	31.4	6.7	18.0	817,502.50
Ashland-Klamath Falls	.....	.....	19.0	177,957.50
Oregon-Washington	27.0	.....	.....	536,076.25
Old Oregon Trail	6.0	13.6	42.5	475,866.97
Baker-Cornucopia	.....	4.7	27.1	178,411.75
McKenzie River	.....	.....	19.8	268,136.44
Crater Lake	.....	.....	22.0	246,000.00
Flora Enterprise	.....	.....	13.0	73,560.00
Coast	19.0	.....	8.8	601,054.00
Mount Hood Loop	.....	.....	12.2	227,567.60
Grants Pass-Crescent City	.....	.....	2.3	62,985.35
Central Oregon	.....	16.7	16.7	197,967.00
Dalles-California	2.0	.....	2.0	46,186.70
Total	380.95	197.50	567.9	$15,012,500.58
10 per cent contingencies	.....	.....	.....	1,501,250.05
10 per cent. engineering	.....	.....	.....	1,501,250.05
Total	.....	.....	.....	$18,015,000.68

State Highway Officials

S. Benson, Portland, chairman (term expires March 30, 1920); W. L. Thompson, Pendleton (term expires March 30, 1922); R. A. Booth, Eugene (term expires March 30, 1921); commissioners, Herbert Nunn, State highway engineer; Roy A. Klein, secretary and assistant engineer.

Headquarters, State Capitol, Salem, Ore.

Revised by Roy A. Klein, secretary State highway commission.

PENNSYLVANIA

State Highway Legislation

In 1911 State Senator William C. Sproul fathered legislation which created for Pennsylvania a State highway system comprising approximately 10,235 miles. This system was composed of the main traveled roads between county seats and the principal cities, boroughs and towns and the main traveled roads leading

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to the State line. In January of 1919 William C. Sproul became governor and he announced that during his 4-year term of office he would make every effort to complete a primary system of highways comprising approximately 3,300 miles of road. Governor Sproul appointed Hon. Lewis S. Sadler of Carlisle State highway commissioner. Governor Sproul and Commissioner Sadler immediately took up the construction proposition and planned a primary roadway system composed of those highways of greatest benefit to the State at large. The system has been laid out regardless of divisional lines such as county boundaries; and it provides a network of roads into which counties and townships can "tie" with intercounty and intracounty highways.

By the terms of the act of May 11, 1911, the State highway department was reorganized. The act of May 31, 1911, provided for the appointment of a State highway commissioner and two deputy highway commissioners. The act of 1919 provides for an assistant highway commissioner and a township highway commissioner. The legislature of 1919 passed a number of acts affecting the highway department and the State's road-construction program. Among the more important of these acts were the following:

Permitting counties to appropriate and expend moneys and to incur indebtedness and issue bonds and other obligations for the improvement and maintenance of State highways, State-aid highways or any other public highways; providing for the construction and maintenance of roads for horse travel when the State highway commissioner deems it advisable; regulating the use of horse-drawn vehicles and requiring lights; regulating the use of cleats on traction engines; providing that the State highway commissioner shall not enter into an agreement with any borough for the building or as to the sharing of the total cost of reconstruction or improvement of a section of State highway within said borough until all necessary pipes and all necessary connections for sewerage, water, gas, heating, light or any other purpose shall have been laid; providing that county commissioners may repair and maintain abandoned or condemned turnpike roads; empowering a county to contract with any city within the county for the construction of certain bridges; forbidding the erection of devices or signs in the form of railway crossing sign boards; permitting the State highway commissioner to purchase and acquire lands containing stone suitable for use in the construction or maintenance of highways and to quarry and prepare the stone; to manufacture any other material used in the construction or maintenance of highways or to sell it to contractors engaged in building or maintaining State highways or State-aid highways, and em-

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powering the State highway commissioner to erect necessary buildings and machinery essential for the proper prosecution of the work in quarrying and preparing stone and manufacturing road material; permitting the State highway commissioner to construct, build or rebuild any highway for the construction, building or rebuilding of which he may contract; providing that no highways may be constructed by counties or townships without the approval of the State highway department.

The legislature of 1919 changed the system of distributing bonus funds to townships. Under an old act the State gave to townships a sum of money to equal 50 per cent of the amount of cash tax collected, but not exceeding $20 per mile. An act passed in 1919 changes the proposition to one of rewards, the sum of $1,000,000 being appropriated as rewards to townships for improvements actually made of a permanent character. The rewards may be withheld upon neglect of supervisors to carry out the instructions of the township commissioner of the State highway department.

Legislation of 1919 also simplified the methods by which boroughs may secure State aid. State aid is granted for improving State and other highways. Counties, townships or boroughs which desire it can proceed in the following manner: The township supervisors or commissioners or borough council of the township or borough in which the road lies shall first make petition to the county commissioners and it shall then be the duty of the county commissioners to adopt a resolution assuming on behalf of the county its share of the cost of the proposed improvement. The county commissioners shall then petition the State highway department for State aid, the cost of the improvement to be prorated among the townships or boroughs, the county and the State, the State paying 50 per cent of the cost of reconstruction, the county and townships or borough the other 50 per cent. If either the township, county or borough desires to act independently of the others it makes application directly to the State highway department and agrees to assume 50 per cent of the total cost, in which event the other 50 per cent is paid by the State. The State pays 50 per cent of the cost of maintenance on all roads other than State highway routes, the other 50 per cent being paid by the township in which the road may lie. Boroughs must assume all maintenance costs. The State-aid fund is apportioned among the several counties of the State according to the mileage of township and county roads.

The act of July 8, 1919, creates a division of township highways in the State highway department. Under the terms of this act the township commissioner, under the direction of the State

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highway commissioner, has general supervision of all township highways and bridges constructed, improved or maintained by the aid of State moneys, except State and State-aid highways. He approves all agreements made by township supervisors for the expenditure of moneys appropriated by the State or the township for road purposes. He also approves plans, specifications and estimates for the erection or repair of township bridges, culverts and highways, as well as compels compliances with laws and regulations relating to such highways and bridges.

In 1913 a maintenance department was established under the direct charge of a maintenance engineer, with a view of standardizing and systematizing all maintenance work under the jurisdiction of the highway department. This division is now so systematized that the operation of each unit of the maintenance force in the field is reflected in this department immediately upon the expenditure of any money, and each dollar expended is so recorded that the department can locate, by referring to station numbers reported, the 100 feet upon which expended and for what used. During 1919 the work of the maintenance division was on a greater scale than ever before attempted in the eastern part of the United States. The condition of the State highway system is better than ever before.

Information.—During 1919 the State highway department inaugurated a bureau of statistics and information. This bureau has charge of the department's publicity and also various information on a wide variety of subjects. The bureau of information has charge also of the scores of detours existing in the State and occasioned by the many construction projects under way. Weekly bulletins are issued detailing the location of these detours.

Local Legislation

Jurisdiction over local roads vests in counties, in boards of county commissioners; first-class townships, in township commissioners; second-class townships, in three supervisors of roads.

Bond Legislation

State Bond Issue.—The voters of the State in November, 1918, approved by a majority of 262,000 a proposition to bond the Commonwealth for $50,000,000 for road-construction purposes. The legislature by an act approved April 18, 1919, enacted the legislation necessary for the floatation of these bonds. As a result $12,000,000 worth of the bonds were issued in 1919 and $18,000,000 will be issued in 1920. The entire $50,000,000 worth of bonds will be issued prior to January 1, 1923. From the proceeds

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of the bonds the State highway department will construct the permanent primary highway system.

The State highway department in its awarding of contracts has insisted upon building only those roads which will stand up not only under present-day traffic, but the traffic of the future. It is planned that the roads constructed from this bond issue shall be of such type that with proper maintenance they will still be in existence long after the bonds have been paid off. The types of construction chosen for the system now being constructed are those best suited for the particular stretches under construction and were selected only after a careful study of the territory to be surveyed, the availability of materials and the traffic which will use the road.

Local Bond Legislation.—During 1919 various counties of Pennsylvania authorized bond issues aggregating about $25,000,000, the money to be spent on the construction of secondary highway systems which connect with the State's primary highway system. The indications are that in 1920 a dozen additional counties will bond themselves for approximately $15,000,000.

The county commissioners of the several counties may borrow money for improving and maintaining the public roads and may issue bonds for these improvements. The amount may not exceed in the aggregate 7 per cent of the total of the assessed valuation of all property in the county at the last triennial valuation.

Convict Labor Laws

All male persons sentenced to county jails and workhouses may be assigned to work on public roads by the prison board. No convict labor was used by the Commonwealth in 1919.

Automobile Registration

The State in 1919 made radical changes in the law governing the registration of automobiles and the fees for registration. Under the new law no motor vehicle or trailer, except hook and ladder trucks and water towers, shall be registerable which exceed an outside over-all length of 336 inches or a width of 90 inches or that exceed a gross weight of 26,000 pounds.

Registration fees are as follows: Motorcycles, $3; bicycle with motor attached, $2; motor vehicles, except such as are equipped with metal tires, when registered prior to August 1 of any year, 40 cents per h. p. or fractional part thereof, provided that the minimum fee shall be $10; commercial motor vehicles, the chassis of which weigh less than 2,000 lbs., on the basis of horsepower. Commercial vehicles, chassis of which weigh 2,000 lbs. or more,

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are divided into seven classes. Fees for these classes are: From 2,000 to 3,000 lbs., $20; 3,000 to 4,500 lbs., $25; 4,500 to 6,000 lbs., $30; 6,000 to 7,000 lbs., $50; 7,000 to 8,000 lbs., $75; 8,000 to 10,000 lbs., $100; over 10,000 lbs., $150.

No registration is required for a trailer weighing less than 500 lbs. For trailers weighing from 500 to 750 lbs., the fee is $2; from 750 to 1,000 lbs., $5; 1,000 to 2,000 lbs., $10; over 2,000 lbs., $15. For any motor vehicle equipped with metal tires the fee is double the regular fee. Registration fees on or after August 1 are one-half the fees given.

The State law forbids the operating of a motor vehicle by persons less than 16 years of age. Persons who have lost the use of one hand or both, or both feet, or whose eyesight is so impaired that objects cannot be clearly distinguished at a distance of 150 feet without the aid of glasses, or who have less than 2 per cent of normal hearing, are considered physically incapacitated, but persons having only one hand may be granted a permit after a hearing.

Registration revenue is paid into the State treasury and is used for the maintenance, improvement and repair of State highways and State-aid highways.

Automobile Legislation.—During the 1919 session of the legislature new laws were added to the statute books pertaining particularly to automobiles. Drastic punishment is provided for automobile thieves in the act of May 31, 1919, in which a fine not exceeding $5,000 and imprisonment not exceeding 10 years are provided. By the act of June 30, 1919, the sale, conveyance, transfer or disposition of second-hand motor vehicles is regulated. This act will do much to prevent the sale of stolen automobiles. In the general automobile law, approved June 30, 1919, companion act to that previously mentioned, garage owners are compelled to keep a record of cars housed in their establishments. The same act provides that no motor vehicles shall be driven at a rate of speed exceeding 30 miles an hour; and the speed of the various classes of trucks is fixed at from 12 to 20 miles per hour. Changes are made in the speed laws calculated to do away with speed traps intended "for revenue only."

Particular attention was given by the 1919 legislature to the character of automobile headlights and the State highway department has issued orders compelling the use of lenses and reflectors complying with the new restrictions. The aim of this law has been to put an end to the head lamps which project dazzling rays of lights.

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Road Funds

Expenditures made under the supervision of the State highway department in 1919 were approximately as follows: State-aid construction, $3,000,000; Federal-aid construction, $6,000,000; State construction, $18,000,000; construction of which State acts as engineer, paying no part of the cost, $2,000,000; toll road purchase, $300,000; maintenance of State highways, $5,000,000; township rewards, $500,000; maintenance of State-aid highways, $600,000; borough repairs and maintenance, $700,000; total, $36,100,000.

The receipts from automobile license fees for maintenance of State highways amounted to $5,000,000; receipts from bond issues, $12,000,000, and legislative appropriations, $8,600,000, making a total State fund of $25,600,000. The rest of the expenditures was made up from Federal-aid and local contributions.

Progress Report

In 1919, up to October 31, the State highway department advertised for the construction of 816.75 miles of new roadway. Contracts awarded during this period were for the construction of 608.13 miles, at a total cost of $25,250,233.46. The contracts awarded were for the following types: Reinforced concrete, 450.90; bituminous concrete, 103.95; vitrified brick, 6.64; bituminous macadam, 45.38; plain concrete, 1.26.

Prior to January 1, 1909, the improved road mileage approximated 3,000 miles. Since 1913 contracts have been awarded for the construction of the following mileages, the cost of each as follows: 1914, 65.05 miles, $1,402,489.04; 1915, 7.33 miles, $153,248.40; 1916, 25.20, $463,146.01; 1917, 34.84, $1,191,358.52; 1918, 120.52, $4,164,835.33; 1919 to September 30, 608.13 miles, $25,250,233.46.

State Highway Officials

State Highway Department, Harrisburg.—Lewis S. Sadler, State highway commissioner; George H. Biles, assistant State highway commissioner; Joseph W. Hunter, township highway commissioner; Colonel William D. Uhler, chief engineer; Howard W. Fry, secretary; Harold E. Hilts, principal assistant engineer; Horatio S. Mattimore, engineer of tests; Paul M. Tebbs, Stewart W. Jackson, Ambrose M. White and Thomas C. Frame, assistant construction engineers; George H. Elsenhans, engineer of plans and surveys; Willis Whited, bridge engineer; Charles S. Lemon, township engineer; W. A. Van Duzer, assistant maintenance engineer; W. S. Hammaker, maintenance inspector; George W. Deaves, maintenance inspector; Benj. G. Eynon, registrar of

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motor vehicles; George M. Brisstar, assistant registrar; William R. Main, comptroller; George G. Hatter, executive manager; M. H. James, bureau of statistics and information.

Prepared by M. H. James, chief bureau of statistics and information.

PHILIPPINE ISLANDS

Under an Act of Congress, approved August 29, 1916, the governor-general is the executive and administrative head of the insular government. The secretary of commerce and communications, a member of the governor-general's cabinet, is in general charge of roads. Design, construction and maintenance of all roads and bridges throughout the islands are in the hands of the bureau of public works, except for city streets and a few unimportant barrio roads and trails. The field work of the bureau is distributed through the 45 provinces under the jurisdiction of 12 American and 29 Filipino district engineers.

Progress

At the close of 1918 there were 4,090.2 kilometers of first-class roads, well graded and surfaced, and thoroughly drained; 2,015.8 kilometers of second-class roads, fairly graded and partially or naturally surfaced; and 3,128.7 kilometers of third-class roads, or traffic routes for carts not included in the first and second-class roads.

At the present time practically every province now has a single connected system radiating from the provincial capital. The extension of the first-class road system is being continued in all the provinces. The policy of adopting a systematic construction program, based on the transportation requirements and financial ability of each individual province is now beginning to bear fruit, especially in Cebu, Pangasinan, Pampanga and Batangas. Hand in hand with this plan goes the steady consolidation of the various provincial and inter-coastal roads. Inter-provincial roads are now under construction joining Iloilo and Antique; Pampanga and Bataan; Laguna and Tayabas; Tayabas and Batangas; Pampanga and Tarlac; Ilocos Norte and Cagayan; Nueva Ecija and Nueva Vizcaya; Albany and Sorsogen; Antique and Capiz. The survey of an inter-provincial road between Bataan and Zambales has also begun, and a location determined for the important inter-coastal Baybay-Abuyog road in Leyte, on which construction is well under way. Much progress was likewise made on the extension of the Cagayan Valley trunk road in Nueva Vizcaya, Isabela, and Cagayan. Grading on the Naga-Pasacao road in Ambos

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Camarines reached the town of San Fernando, and extensive trail works was undertaken in the mountain province and the Department of Mindanao and Sulu.

Maintenance

All of the first-class roads mentioned are constantly maintained, every square meter thereof coming daily under the eye of a caminero. The second-class roads are generally intermittently maintained. The average number of kilometers maintained, and the total cost of road maintenance during the past year, under the two systems in vogue in the islands are given below.

Caminero (cantonnier or patrol) system.....	4,023.4 km.	P2,756,810.70
Gang system.....	2,773.5 km.	589,450.32

Type of surface: Stone, 1,380.7 km.; gravel, 2,838.0 km.; coral, 1,127.6 km.; unsurfaced, 3,888.4 km.

Road Funds

The funds expended in the islands during 1918 on roads and bridges, which amounted to 7,257,916.70 pesos, were purely local funds, insular, provincial and municipal; the total expenditures of the insular government amounted to 96,121.81 pesos, and the expenditures of the provincial and municipal governments combined amounted to 7,161,794.89 pesos.

Motor Vehicles

The licensing of motor vehicles is in the hands of the bureau of public works, and also the operation of the Benguet Automobile Line, which operates over the Benguet and Naguilian roads. The revenues from both these sources are generally allotted to special maintenance projects.

At the close of 1918, there were 7,379 motor vehicles registered in the islands, of which 1,143 were motorcycles and other motor vehicles having less than four wheels.

Highway Officials

Director of public works, Jose Paez; supervising architects, Juan M. Arellano and Tomas Mapua; chief designing engineer and chief constructing engineer, G. E. Gordon; supervising engineer, A. T. Sylvester; acting chief designing engineer, E. C. Earle. Main offices, Manila.

Prepared by C. B. Hodgis, assistant chief Bureau of Insular Affairs, War Department.

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PORTO RICO

Under an Act of Congress, approved March 2, 1917, the governor exercises supreme executive power over the island, and the commissioner of the interior has charge of all insular public works. The political code of Porto Rico subdivides the latter's office into various divisions and bureaus, of which the bureau of public works is intrusted with highway affairs.

The main roads of the island are 1,185.4 kilometers long. Of this total 275 kilometers were built by the Spanish government, 141.7 kilometers by the U. S. military government, and 768.7 kilometers by the civil government. These roads cross the island in all directions and reach all cities and towns. Most of them are good automobile roads.

Road Funds

During the fiscal year 1917-1918, $608,886.41 were spent for the maintenance, repair and construction of insular roads and bridges. There are no counties or townships in Porto Rico, and the $608,886.41 expended were taken from insular funds. The legislature of Porto Rico in 1916 authorized the sale of $2,000,000 worth of bonds, $1,000,000 of which have already been issued. The proceeds received from the sale of these bonds are to be used for the purpose of constructing roads and bridges. There is now available from this source $667,350.95.

The municipalities receive 90 per cent of all regular property taxes, 8 per cent devoted to municipal roads being included.

Automobiles

The licensing of automobiles is in the hands of the division of disbursements and accounts, department of the interior, San Juan, Porto Rico.

At the close of the fiscal year 1917-1918, there were 4,529 automobiles registered in the island.

Officials

Governor, Arthur Yager; commissioner of the interior, Guillermo Esteves; assistant commissioner, Edmund Enright.

Prepared by C. B. Hodgis, assistant chief of Bureau of Insular Affairs, War Department.

RHODE ISLAND

State Aid Legislation

The State board of public roads, consisting of five persons, one from each county, is appointed by the governor for a term of five

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years. The board has direct control of the expenditure of all appropriations by the legislature for road improvement, and has supervision over the construction and maintenance of all State roads.

The entire cost of construction and maintenance of State roads is paid by the State. At the close of 1918 there were 325 miles of State roads under the direct control of the State board, all of which are improved.

A State bond issue of $600,000 was authorized in 1906 to bear 3 per cent interest and additional bond issues of $600,000 were made in 1909 and 1912 for use in completing the system of State roads. No more than one-third nor less than one-seventh of the available appropriation in any year is expended in any one county. The proceeds of automobile licenses and fines are used for the repair of State roads under the direction of the State board.

In addition to the State highways, State aid is granted as follows: Whenever any town shall make an annual appropriation equal to or in addition to the sum of 20 cents on each $100 of taxable valuation, and whenever the electors shall vote that the appropriation be expended under the direction of the State board of public roads a sum equal to one-fifth of the moneys so appropriated by any town is annually appropriated by the State for the care and maintenance of the public highways and bridges of the town. At the close of 1918 there were 1,795 miles of town roads.

In 1912 legislation was enacted providing that bridges on State roads shall be under the control of the State board of public roads.

At the January session, 1917, the general assembly passed a resolution assenting to the provisions of the Federal aid act and appropriated $174,985.65 to meet an equal sum apportioned by the secretary of agriculture to the State. At the January session, 1919, the general assembly assented to the amended Federal aid act and appropriated $466,123.81 in addition to the amount previously appropriated to meet an equal sum apportioned by the Secretary of Agriculture.

Local Legislation

The local roads are under the town council of the township, who usually appoint a highway commissioner to look after the roads.

Automobile Registration

The law provides for annual registration with the State board of public roads. The fees for registration and licenses are:

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Automobiles, not over 15 horsepower, $5; 15 to 30 horsepower, $10; 30 to 40 horsepower, $15; over 40 horsepower, $25. Motor trucks with carrying capacity of 1 ton or less, $7; 1 to 2 tons, $10; 2 to 3 tons, $13; 3 to 4 tons, $16; 4 to 5 tons, $20; 5 to 6 tons, $24; 6 to 7 tons, $28; 7 to 8 tons, $32; 8 to 9 tons, $36; over 9 tons, $40; motorcycles, $2. Manufacturers' and dealers' license fees, $25, when not operating over 5 automobiles or trucks at any one time; $5 for each additional automobile or truck; motorcycles owned by or under control of a manufacturer or dealer, $10; licenses or renewals or duplicates thereof to operate a motor vehicle, $1.

The revenue derived from registrations, fines and forfeitures is paid into the State treasury to be used for the repair and maintenance of State roads under the direction of the State board.

Receipts and Expenditures

Receipts from 1903 to December 31, 1918, were as follows: Bond issues, $1,800,000; appropriations, $914,921.34; automobile law, $1,765,511.75; received from towns for additional widths, $88,399.27; special road tax, $658,125.59; miscellaneous, $36,036.63; total, $5,262,994.58.

Expenditures on trunk line for construction from 1903 to December 31, 1918, were $2,214,831.67; for reconstruction $1,233,512.60; for repairs and maintenance, $1,198,115.78; for surface treatment, $44,481.53; for engineering, $427,592.24; for advertising, $11,587.48; for tools and machinery, $69,674.48; total, $5,199,795.93.

Expenditures for the year 1918; reconstruction, $397,132.38; repairs and maintenance, $200,011.17; advertising, $970.62; tools and machinery, $14,650.91; engineering, $39,875.01; total $652,-640.09; expenditures on bridges for year 1918, $118,030.95.

The State board had for the year 1919, receipts from the special road tax of three-tenths mill, $240,000; automobile registration, $375,000; appropriation, $200,000; Federal aid (State and Federal appropriations), $745,822.28; total, $1,560,822.28, and for bridges, $154,968.31.

Progress Report

Considerable reconstruction of wornout macadam was accomplished during 1918. The sections of highway selected for reconstruction were all macadamed many years ago and were in wretched condition for present-day travel because the macadam

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was badly worn and because of serious sub-soil difficulties. All of the sections rebuilt were upon main trunk lines.

The design of foundations and drainage structures and the selection of types of wearing surfaces received very careful consideration. Although costs of all construction work were high during the year, no attempt was made to save expense by slighting foundations or drainage. The extent of motor-truck traffic upon all of the main trunk lines makes it necessary to have very heavy foundations over certain soils. The reconstruction work accomplished under the present program and according to the present standards of the State board of roads is free from foundation troubles.

The urgent necessity existing during the past year for conservation in the transportation of road materials caused the board to give careful consideration to the selection of types of construction and to materials to be used. Upon the greater part of the work the binder was the only material which it was necessary to ship in. The conditions met with during the year interfered rather seriously with the rate of progress of reconstruction work.

Eleven and two-tenths miles of old worn out water-bound macadam 14 feet wide were reconstructed with bituminous macadam and bituminous concrete and the width increased to 18 feet with State funds during the year 1918.

The first project involving the expenditure of the allotments of Federal aid funds due Rhode Island for the fiscal years ending June 30, 1917, and June 30, 1918, was the reconstruction of a section of worn out waterbound macadam 3.8 miles in length with bituminous concrete, on the post road between Narragansett Pier and Westerly. Work was begun late in 1917, but the road was not completed until the fall of 1918.

On January 1, 1919, the State highway system embracing 325 miles was all improved and consists of the following types; water-bound macadam, 196 miles; bituminous macadam, 122 miles; bituminous concrete, 6 miles; and cement concrete, 1 mile.

State Highway Officials

State board of public roads, Providence: Abram L. Atwood, Benjamin F. Robinson, Frank Cole, Michael M. Van Beuren, J. Henry Woodard, members of the board; Irving W. Patterson, chief engineer; Peter J. Lannon, chief clerk.

Prepared by I. W. Patterson, chief engineer.

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SOUTH CAROLINA

State Aid Legislation

State participation in road building is limited to educational, advisory, and supervisory assistance administered by a State highway commission established in 1917. No money aid is extended by the State, but 20 per cent of the automobile registration fees is used for the support of the State highway department, while 80 per cent of the fees is refunded to the counties for roads and bridges. The State exercises no control over the expenditure of these funds except on request of local authorities. For a number of years previous to 1917 the department of agriculture, commerce and industries collected and disseminated information and statistics on road building, and issued road maps and route books.

The State highway commission is composed of two non-salaried members appointed by the governor and three ex-officio members, the senior professors of civil engineering of the Military College of South Carolina, of the Clemson Agricultural College and of the University of South Carolina.

A highway engineer is appointed by the commission for an unlimited term. He must be skilled and experienced in the design, construction, and maintenance of roads and bridges. Upon the recommendations of the State highway commission the State highway engineer appoints two assistant engineers, which appointments may be based upon a civil service examination.

The highway department is composed of two divisions, viz., engineering and automobile licensing and registration. The engineering division, administered by two assistants under the State highway engineer, has charge of the work, requested by local authorities, of making surveys, preparing plans, specifications and estimates, and the supervision of road and bridge work on Federal-aid projects. The registration and licensing of automobiles is administered by a clerk who is secretary to the commission, and who reports to the State highway engineer.

Federal-aid funds are expended with county funds on the State highway system. This system includes 2,550 miles, or 6.5 per cent of the total road mileage of the State and connects the county seats and principal market centers. When local authorities request Federal aid, plans specifications, and estimates are prepared by and at the cost of the State. The work is done by the counties by contract, force account, or prison labor, and under the inspection and supervision of the State highway department. When completed the roads will be maintained by the counties under State supervision. The cost of construction is borne 50

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per cent by the counties and 50 per cent by the Federal-aid fund. The counties pay the entire cost of maintenance.

Local Legislation

Except where special laws apply, the control over roads and bridges in the several counties vests in a county board of commissioners composed of the county supervisor as chairman, elected by the people for a four-year term, and two commissioners appointed by the governor on the recommendation of the county delegation to the general assembly. Some counties have, by law, more than two commisioners and several counties operate under special laws. District overseers have immediate control over the roads in the various townships. They are appointed by the county board, or subject to its approval, or by the township board of commissioners in counties where such boards exist.

All roads in the State, including the proposed State system, are county roads, built and maintained under the direction of county authorities with county and township funds. Surveys, plans, specifications and estimates may be prepared and construction and maintenance may be supervised by the State highway department on the request of the local authorities.

Bond Legislation

There is no general law authorizing the issuance of road and bridge bonds. Such bonds are authorized by special acts of the legislature.

Automobile Registration

The automobile license tax is a flat rate of 25 cents per horsepower. One-fourth of that amount may be paid each quarter.

Road Funds

No State road funds are available with which to aid the counties.

County commissioners may annually levy a 1-mill tax, the proceeds to constitute a part of the county-road fund. They may also levy a similar tax on property in any township on written request of two-thirds of the property owners of the township. An additional levy of 2 mills may be assessed for two-year terms by the county board on any township if agreed to by a majority vote of the electors who own real and personal property subject to taxation. One-half of the taxes derived from the sale or manufacture of timber is used for the improvement of public roads.

Unless exempt by law, all male persons between certain ages

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varying from 18 to 21 to 50 and 55, are required to work from 2 to 12 days on the public roads, or to commute the labor in cash at the rate of from $1 to $3 per day. The conditions under which statute labor is applied vary under the special laws applying to the various counties.

It is estimated that the various counties and townships expend about $1,750,000 annually for road and bridge purposes.

State Highway Officials

State highway commission: Robert G. Thomas, chairman; members: Hale Houston, ex-officio; M. Goode Holmes, ex-officio; C. O. Herron; Thomas W. Cothran, J. Roy Pennell, State highway engineer. Headquarters, Columbia.

Revised by J. Roy Pennell, State highway engineer.

SOUTH DAKOTA

State Aid

A State highway commission consisting of three members serving without salary was established in 1913. The work of the commission was advisory and educational, no State funds or State control of roads being provided.

In 1917, a State highway commission was established consisting of the governor as chairman, the State engineer as secretary, and a third member appointed by the governor. The commission was vested with power to superintend the construction of roads to which State and Federal funds were applied. The State funds were derived from a tax levied at the rate of not exceeding a tenth of a mill. From the proceeds of this tax, the legislature appropriated $100,000 for the fiscal year ending June 30, 1918, and $120,000 for the fiscal year ending June 30, 1919. These amounts were available for the payment of salaries and expenses for the State highway department and for the construction of State-aid roads. Eighty per cent of the State funds were expended in the counties in which collected.

On March 4, 1919, a new highway commission of three members was established consisting of the governor, ex-officio chairman, and two members appointed by the governor, who were to serve four years. The appointive members devote their entire time to the duties of their office and receive an annual salary of $3,600 each. The State highway engineer is appointed by the commission for a term of four years and receives a salary not to exceed $3,600 per annum.

The highway commission is authorized to lay out a system of

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not over 5,000 miles of trunk line highways connecting the county seats and cities with a population of 750 or more. This system is to correspond as nearly as possible with the five-year program on which Federal funds are now being applied. The commission is authorized to apply all State allotments of State and Federal money to the trunk line roads, 75 per cent of all State and Federal funds being apportioned to the various counties on the basis of assessed valuation, the remaining 25 per cent being expended at the discretion of the highway commission, after deducting the necessary expenses for the maintenance of the commission. The law does not specifically state what percentage of the cost of trunk-line roads is borne by the State or by the counties.

Local Roads

Jurisdiction over county roads is vested in boards of county commissioners and the county highway superintendent. A county highway system of primary roads is laid out in each county and is built and maintained by the county highway superintendent, in accordance with the plans and specifications furnished by the State highway commission. County boards may levy a 2-mill tax, and when authorized by a majority vote, this may be increased to 5 mills. Nearly all counties levy the full legal limit of 2 mills. Secondary roads are constructed and maintained by boards of township supervisors from funds derived from direct taxation at not to exceed 50 cents on each $100 of assessed valuation. A poll tax may be levied at the rate of $1.50 per capita, which may be worked out.

Bonds

Sinking-fund bonds may be issued by county boards in amounts not exceeding 5 per cent of the total assessed valuation when authorized by three-fourths of the electors of the county. Such bonds shall become due in not less than 20 years from the date of issue, and they may bear interest at rates not exceeding 5 per cent.

Bonds may be issued by township boards in an amount not exceeding 5 per cent of the total assessed valuation of the township, and in no case to exceed $5,000. Such bonds may bear interest at a rate not exceeding 10 per cent, and may not run more than 20 years. No county or township bonds are outstanding in South Dakota.

Convict Labor Law

When in the opinion of the sheriff any convict sentenced to hard labor can be more profitably employed outside of the jail or yard, it is his duty to employ him either in work on public streets or highways or otherwise.

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Automobile Registration

The law provides for annual registration with the secretary of State. The application for registration is filed with the county treasurer and the payment of fees made to him. The schedule of registration fees is: Automobiles, $6; motorcycles, $2. Ten per cent of the gross revenue is transmitted to the secretary of state with the application to be expended in payment of costs in connection with registration, and 90 per cent is retained for expenditure only in grading, crowning, draining, dragging, graveling or macadamizing public highways of the county under the direction of the board of county commissioners.

Road Funds

There are $11,250,000 available for road building in South Dakota for the three-year period ending 1921, including $4,458,000 of Federal aid, a State bond issue of $6,000,000, and $667,000 derived from appropriation from annual tax levies. All of these funds are for State roads only, and although apportioned to the counties, must be used on the State system.

State Highway Officials

Peter Norbeck, chairman; Andrew Marvick, commissioner; M. L. Shade, commissioner; George H. Henry, secretary; Frank S. Peck, highway engineer; F. W. Schreiber, first assistant highway engineer; J. F. Mangold, bridge engineer; C. J. Loomer, chief draftsman.

Compiled from information furnished by Frank S. Peck, State highway engineer.

TENNESSEE

State Aid Legislation

In 1915, a State highway commission was created consisting of the governor, State geologist, the dean of engineering of the University of Tennessee, and three members appointed by the governor. This commission served without compensation.

In 1919 the legislature authorized the establishment of a paid commission consisting of three commissioners, one of whom is the chairman, one the secretary and one the chief engineer. The commission was required to prepare a general highway plan of the State including the main roads, which when improved under State direction with State or Federal aid or local funds will form a connected system. This primary trunk road system comprises approximately 4,300 miles.

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The State provides not less than one-sixth of the cost of construction, while the counties are responsible for the maintenance of the roads when constructed; the maintenance, however, being taken care of from the funds derived from automobile registration fees and expended under direction of State highway commission.

The legislature of 1917 authorized the commission to execute agreements with the Federal Government incident to receiving Federal aid. All Federal-aid funds are applied to the selected State system.

Local Legislation

The local roads in each county are under the county court, composed of the county judge and four lay members, who divide the county into road districts and appoint a road commissioner for each. The commissioner may appoint a road overseer for each section of his district. The county court also appoints a board of turnpike commissioners to look after toll roads in the county. If any county does not care for road districts, it may elect a county board of road commissioners, of three members, to have charge of all roads in the county. Many have done so, employing county engineers to have immediate charge of the work.

Counties levy a tax on property and privileges for road purposes. The tax on property varies from 5 to 25 cents on each $100 of valuation, a portion of which may be worked out. The tax on privileges is not less than one-fourth of the amount assessed for county purposes, and not exceeding two-thirds of the amount of this tax may be paid in labor.

From five to eight days' labor on the roads is required of all male citizens, and in two counties the owners of wagons and teams may be required to donate five to eight days' use of them to road work.

Bond Legislation

The county court of any county, when authorized by a majority vote at an election held for the purpose, may issue coupon bonds for highway purposes in any amount which will not increase the outstanding indebtedness of the county to more than 10 per cent of the taxable valuation; provided that a two-thirds vote may authorize a bond issue that may increase the outstanding indebtedness of the county to an amount not to exceed 15 per cent. These bonds shall bear interest at not exceeding 6 per cent, shall run not more than 40 years, and shall not be sold for less than par. The county courts provide a levy for interest and for retiring the bonds and also for creating an annual maintenance fund equal to 2 per cent of the bonds issued.

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To meet Federal aid the county courts are authorized to appropriate an amount not to exceed double the Federal aid, and in case there are insufficient funds in the treasury, may issue bonds not to exceed 3 per cent of the taxable valuation.

Convict Labor Laws

County convicts may be worked upon the public highways of the county subject to the direction of the county court. State and county convicts may be worked by the State highway commission. During 1919, 50 convicts were used on State road work

Automobile Registration

Automobiles are registered with the State highway department. The fees are: Automobiles and motorcycles, 50 cents per horsepower; electric automobiles, $25 each, and $5 per ton carrying capacity; motor trucks, freight and passengers, 50 cents per horsepower, plus $5 per ton carrying capacity.

Road Funds

A state-wide tax of 1 mill is levied from which approximately $1,250,000 yearly is realized for State aid. In addition to this fund the fees derived from the registration of automobiles amounts to approximately $400,000 per year, 10 per cent of which is retained by the State for the maintenance of the State highway department, while 90 per cent is returned to the counties from which it is derived for the maintenance of State highways under State direction.

The State-aid highway funds are so distributed that each county will receive $25,000 of State money during the period from 1917 to 1922, thus avoiding the necessity of apportioning State funds and building a piece of State-aid road in each county each year.

The total funds available from the Federal Government, including 1920, amount to approximately $4,000,000. This fund will be matched by an equal fund from the State. In addition to this amount the various counties have bonded for approximately $6,000,000.

Progress Report

The State highway program for 1920 calls for an expenditure of approximately $8,000,000. Actual contracts have been let covering the expenditure of $847,021.81 on Federal-aid projects and a total of $161,154.81 on State-aid projects. Surveys calling for the expenditure of $2,700,000 were completed last fall and surveys were to be completed by January 1, 1920, which will

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require for construction approximately $4,405,000, making the grand total of road work provided for on January 1, 1920 $8,113,176.62.

State Highway Officials

State highway commission: W. W. House, chairman; W. T. Testerman, secretary; W. P. Moore, chief engineer; R. C. Fergus, assistant engineer; W. P. Butler, division engineer; L. W. Erickson, bridge engineer; R. L. Stockard, chief clerk and automobile registration clerk. Headquarters, Nashville, Tenn.

Revised by W. P. Butler, division engineer.

TEXAS

State Aid Legislation

The State highway department was organized under provision of the highway act of 1917. It consists of a commission of three members appointed by the governor. The State highway engineer is appointed by the commission and is in administrative control in the absence of the commission, and acts with the highway commission in an advisory capacity without vote. The commission has designated a system of State highways comprising about 12,600 miles upon which State aid from the State highway fund is granted if the counties agree to contribute 75 per cent of the cost.

Local Legislation

Local roads are under the charge of a county commissioner's court. Where the county judge is chairman, he usually appoints a county engineer or superintendent, otherwise, the court makes the appointment.

Bond Legislation

State—There is no provision for State bonds for road purposes. An amendment to the constitution, voted upon on November 4, 1919, to authorize an issue of $75,000,000 of State bonds for road improvement, failed to carry.

Local—Any county, political subdivision or other defined district of the county, upon a vote of two-thirds of the resident property-holding taxpayers, may issue bonds for road purposes in an amount not to exceed one-fourth of the assessed value of the real property therein. These bonds shall run for not less than 20, nor more than 40 years, with such option of redemption as may be fixed by the commisioner's court, bear not more than 5½ per cent interest per annum and must be examined by the attorney-general and registered by the State comptroller of public accounts.

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A tax must be levied by the county commissioner's court sufficient to pay the interest on the bonds and produce a sinking fund sufficient to redeem them at maturity. Each political subdivision or defined district issuing bonds is made a body corporate and may sue and be sued in like manner as counties. The county commissioner in whose precinct the political subdivision or defined district is located is ex-officio road superintendent of the road district with power to contract for and on behalf of it.

The amount of outstanding bonds to December 1, 1917, was approximately $46,120,000, and on December 18, 1918, totaled to $51,950,000, while on October 1, 1919, outstanding bonds reached the sum approximately $126,000,000.

Convict Labor Laws

The commisioner's court of counties may require all male convicts, not otherwise employed, to labor upon the public highways under such regulations as may be deemed most expedient. Each convict worked on the roads in satisfaction of any fine and cost shall receive a credit of 50 cents on each day he may labor and reasonable commutation of time may be granted as a reward for faithful service and good behavior, provided it shall not exceed one-tenth of the whole time.

Automobile Registration

An annual license fee of 35 cents per horsepower (N. A. C. C. rating) is charged for the registration of motor vehicles. In any case the minimum annual fee is $7.50. Trucks with net carrying capacity of more than one ton take a license fee based on their net carrying capacity. All fees are prorated quarterly and are paid to the tax collector of the several counties, one-half the amount of the fees collected being retained in the counties as a special road maintenance fund, the other half going to the State highway department for expenses of the department and road construction purposes.

Road Funds

The State commission's half of the automobile fees in 1919 amounted to about $1,350,000, and will be about $1,750,000 in 1920. This fund and Federal aid are the only funds at the disposal of the State.

There is a county property tax of 15 cents on the $100 for roads and bridges and a special road fund of the same amount may be authorized by a majority vote of the electors. County road warrants may also be issued for road and bridge work.

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Progress Report

Up to November, 1919, there had been completed, under the supervision of the State highway department, approximately 350 miles of State-aid roads, with approximately 1,000 miles in the course of construction.

State Highway Officials

State highway commission: R. M. Hubbard, chairman of commission; C. S. Fowler, commissioner of registration; C. N. Avery, commissioner of construction; Rollen J. Windrow, State highway engineer. Headquarters, Austin, Texas.

Prepared by Rollen J. Windrow, State highway engineer.

UTAH

State Aid Legislation

The State road commission is composed of the following ex-officio members: The governor, the state engineer, the state auditor, the secretary of state, and the attorney-general, all of whom serve without additional compensation.

The legislature designates the roads which comprise the system of State roads which are constructed with State and local funds under the direction of the commission. This system, at present, includes 3,300 miles. The percentage of the cost paid by the State is left to the discretion of the commission.

The commission has charge of the expenditure of State road building funds, makes the plans, specifications and estimates and awards contracts for improvement of State roads. The State road engineer, appointed by the commission, is the secretary and chief executive official of the commission and has active charge of all construction and maintenance on State roads.

The State road commission is authorized to do all things necessary fully to carry out the coöperation contemplated by the Federal-aid road act and is also authorized to select the Federal aid projects and to make disposition of Federal and State-aid road funds in the construction of State roads.

Counties are authorized to enter into agreement with the U. S. Secretary of Agriculture as provided for in section 8 of the Federal-aid road act for the improvement of roads within or partly within national forests.

Local Legislation

Jurisdiction over local roads vests in boards of county commissioners. The county commissioners annually appoint the

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county road commisioner, who has immediate charge of construction and maintenance of county roads.

Bond Legislation

State bonds amounting to $4,800,000, the proceeds from which are to be used in meeting the State's share of the cost of State roads, were authorized in 1919.

The board of county commissioners may contract bonded indebtedness by an order specifying the purpose for which the indebtedness is to be created and the amount of the indebtedness, and by providing for submission of the proposition to the electors of the county at the next succeeding general election, or at a special election to be called for that purpose. Only such qualified voters as have paid a property tax in the county in the year preceding the election are permitted to vote on the question of issuing bonds. A majority of those voting is necessary to authorize the issuance of bonds. If the bonds are issued, the board levies a tax necessary to pay the interest on them and to create a sinking fund for their redemption at maturity. Bonds shall not be in an amount which, including existing indebtedness, will exceed 2 per cent of the value of the taxable property of the county.

Convict Labor Laws

Convict labor may be utilized in providing road material and also actual construction. Prisoners in county jails may be required to work on the county roads under regulations made by the board of county commissioners, and prisoners in the State prison may be required to work on the State roads. The State board of pardons is required to make provision for granting privileges and reduction of sentence for good behavior on part of convicts employed on roads.

Automobile Registration

Automobiles are registered annually with the secretary of state. The fees are as follows: Passenger cars not exceeding 25 horsepower, $5; 25 to 40 horsepower, $10; over 40 horsepower, $15; electric pleasure cars, $10; trucks equipped with solid rubber or cushion tires, all fees based upon combined weight and carrying capacity of truck and load; 1 ton or less, $10; 1 to 2 tons, $15; for each additional ton, $7.50; for all trucks equipped with pneumatic tires, two-thirds of the above rate is charged, but in no event shall less than $10 be charged; for a metal-tired truck or trailer an advance of 100 per cent is charged; for trailers or semi-trailers based on combined weight and carrying capacity, 2 tons or less, $5; for each additional ton or part thereof, $5.

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It is unlawful to operate on any State road a truck or trailer with a combined weight of truck or trailer and load of over 20,000 lbs. The speed of motor trucks carrying more than 3 tons is limited to 8 miles per hour. Metal spikes or devices, except chains used on rubber tires, are illegal on any State highway.

The receipts from automobile registration fees are paid into the State treasury and are used to amortize and pay the interest on State road bond indebtedness.

Road Funds

State funds to pay the State's portion of the cost of State roads are derived from State road bonds, of which $4,800,000 were authorized in 1919.

Local road funds are obtained by taxation levied by the board of county commissioners at rates not to exceed 3 mills. Additional funds may be raised by the counties to pay the county's share of the cost of State roads. This additional tax must not exceed 5 mills and is fixed by the State highway commission.

Progress Report

On March 13, 1919, there were 2,300 miles of State road designated. During 1918, 443 miles were graded, 70 miles surfaced with gravel, 19 miles with shale, 27.5 miles with concrete, 12 miles with bituminous materials and 20 miles with clay and sand; 15 bridges and 175 culverts were built. The entire length of State roads was maintained.

State Highway Officials

State road commission: Governor Simon Bamberger, chairman; Harden Bennion, vice-chairman; Ira R. Browning, secretary and engineer; G. F. McGonagle, Joseph Ririe, Dan B. Shields.

Revised by Ira R. Browning, secretary and engineer.

VERMONT

State Aid Legislation

The State highway commissioner is appointed biennially by the governor with the approval of the Senate, and has control over the expenditures of all moneys appropriated by the State for highway purposes. He may appoint district highway commissioners, not exceeding twelve in number, to assist in the performance of his duties. He is also allowed such additional assistance as may be necessary. He must hold a meeting at least once a

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year, in each county in the State, of the road commisioners, selectmen, and others who are interested in road work, for the discussion of matters pertaining to road building.

Some years ago, the total road mileage of the State, which is nearly 15,000, was divided by the selectmen and road commissioners of the towns with the approval of the State highway commissioner into what is known as selected or State roads and town roads. The selected road mileage is about 4,000. It comprises the trunk lines going north and south and east and west, across the State, and also those roads which are of most local importance. Other roads are known as town roads. All Federal-aid money and all State money, with the exception of $75,000 per annum, which goes to town roads, is expended on the State roads.

By an agreement between the State highway commissioner and the selectmen and road commissioners of a town, or the trustees of a village, any portion or all of the State roads within the limits of a town or incorporated village, may be placed in the care of a patrolman, the town or village paying annually out of its road money toward the expense of the patrol work what seems to the State highway commissioner to be a reasonable amount, and the State then employs the patrolman to do the work, and pays from the maintenance fund whatever balance is necessary to prosecute the work.

There is a State appropriation of $50,000 which is available to towns if they desire to build or rebuild bridges on the State roads. The State highway commissioner may grant aid to a town from this fund to an amount which is not in excess of one-third of the actual cost of the improvements or construction of a bridge and not in excess of $1,500.

In order to match Federal aid the legislature of 1918-19 appropriated $600,000 and passed other legislation making it possible to match the remainder of Federal-aid money from other highway funds.

Local Legislation

Towns may at their annual meeting elect one or two road commissioners to have charge of the road work in the town for the ensuing year, or if the town so votes, the commissioners may be appointed by the board of selectmen.

Bond Legislation

It has been the policy of the State to enter into only such road improvement as could be paid for with the funds available from taxation, and up to the present time no bond issues have been

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made for State road work. There is, however, on the statute books a law which allows any town or incorporated village or city to issue bonds to an amount not exceeding three times its grant list—1 per cent of the assessed valuation for the purpose of purchasing roadmaking apparatus and building permanent highways.

Automobile Registration

Automobiles are registered with the secretary of state. The fees are: Automobiles, $1 per horsepower for first year, 75 cents per horsepower for second year, and 50 cents per horsepower for all subsequent years; motor trucks, trailers and traction engines, 1-ton carrying capacity, $25; 1 to 1½ tons, $30; 1½ to 2 tons, $40; 2 to 2½ tons, $50; 2½ to 3 tons, $75; 3 to 4 tons, $100; each additional ton or fraction thereof, $25. Operator's license, $2; dealers' and manufacturers', $25, and for chauffeurs, $2. All motor vehicles are exempt from property taxes. Non-residents are exempt to the same extent that the laws of his State grant to owners and operators of cars owned in Vermont.

Road Funds

A State tax of 5 per cent on each dollar on the grand list of the State (½ mill on the dollar)) is annually levied. The proceeds from this tax are divided among the towns, cities and villages according to their road mileage. The amount raised by this tax in 1919 was $128,683.55. The present law appropriates annually $260,000, which is known as the State-aid fund. Out of this is first deducted the expense of administering the law, and any town or city which votes prior to April 1, from $100 to $1,000 for State road work, can have the amount voted, matched by the State out of this fund. The remainder of this fund, after deducting the two above items, is known as the surplus fund, and can be used by the State highway commissioner, as in his judgment will be for the best interest of the State highway system.

After paying the expense of collecting the automobile registration and license fees, and furnishing number plates, the balance is paid into the State treasury and placed to the credit of the highway maintenance fund, all of which is used, with the exception of $75,000, in maintaining and improving what is known as the selected or State roads. The $75,000 is devoted to the improvements of the town roads and is divided among the towns of the State according to their unselected road mileage. It is estimated that the income from the registration and license fees this year will be $450,000.

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State Highway Officials

State highway commissioner, Stoddard B. Bates, Derby; assistant to highway commissioner, R. S. Currie, Barre; secretary, Miss M. E. Price, Montpelier; bookkeeper, Arthur H. Gates, Franklin; district highway commissioner, W. N. Cady, Middlebury; M. E. Carpenter, Charlotte; George W. Plumb, Readsboro; M. M. Stocker, Danville; J. C. Towle, Enosburg Falls; F. L. Dudley, Randolph; A. B. Cobleigh, Newport; C. F. Willis, Rutland; E. C. Hayden, Montpelier; D. T. Perry, West Brattleboro; M. E. Noyes, Sharon; State engineer, H. M. McIntosh, Burlington; assistants to State engineer, George W. Reed, Montpelier; James L. Davis, Manchester.

Revised by R. S. Currier, assistant commissioner.

VIRGINIA

State Aid Legislation

A State highway commission consisting of five members is appointed by the governor, with the consent of the Senate. The members of the commision are appointed for terms of six years, the terms of not more than two to expire in any one year. The governor appoints a State highway commissioner for a term of six years.

The State highway commissioner has power to locate and establish the roads comprising the State highway system between points named in the act of legislature creating such a system. This system embraces 28 routes and includes about 3,740 miles. Local road authorities, or 50 or more citizens may within 30 days, appeal from the rulings of the State highway commission relative to the locations, to the commission as a body. The commission may hear evidence and argument as to desired changes in, the locations and decide as to whether any changes shall be made. Should no appeal be made within 30 days from the date on which the State highway commission has filed report of the location of any State highway with the clerk of the county, or the clerks of several counties, through which the road is located, the location as made by the State highway commissioner stands.

The State highway commissioner also has the power, subject to the approval of the commission, to apportion to the various road projects in the State highway system, the available State and Federal funds for each calendar year, the approval shall not be given until after a public hearing has been had at which the various sections of the State may, through interested citizens, express a desire for modifications or changes in the appropriations.

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The commission may acquire rights of way under the power of eminent domain. It has also the power to fix the salaries of all assistants and employees who are selected by the State highway commissioner and subject to removal by him. It is given power to make and enforce rules and regulations governing traffic on all State highways and duly authorized employes of the commission have police power in the enforcement of them.

Each section of the State highway system improved under the commission is maintained by and at the expense of the State. Federal aid is applied to projects in the State highway system exclusively.

In addition to the State highway system provision is made for State aid to the several counties which is apportioned in proportion to the State taxes paid in from each, and which must be met by at least an equal amount of local funds. State aid may be applied to either new construction or to the maintenance of roads already improved. All State-aid work is carried on by the several counties, but must be approved and accepted by the State highway commissioner before the State portion of the cost is paid over to the county. The counties make the selection of State-aid projects, but plans and specifications for them must be approved by the State highway commissioner before the work can be undertaken.

Local Road Legislation

Jurisdiction over county and district roads is vested in county boards of supervisors, one from each district. Each board is authorized to appoint a county road superintendent or a road superintendent for each district or group of districts, or it may appoint both county and district superintendents.

Bond Legislation

The State constitution forbids the issue of State bonds except to meet military emergencies, but counties or magisterial districts of counties may bond for road improvement. Upon the petition of a majority of the board of supervisors of any county or upon the petition of 150 freeholders of a county, the circuit court may, upon the certification of the State highway commissioner that the proposed amount of money and type of construction are adequate, order an election to be held to determine whether bonds shall be issued. The amount of outstanding bonds cannot exceed 10 per cent of the total taxable values of the county or district. The bonds cannot be for a period greater than 34 years and the interest rate must not be greater than 6 per cent. The board of supervisors must make an annual levy sufficient to meet the in-

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terest on bonds and create a sinking fund which will retire the bonds within the time specified, also required to make a levy sufficient to create a maintenance fund equal to 3 per cent of the total bond issue, for the upkeep of the roads when completed. All work done with funds derived from county or district bonds must be under an engineer approved by the State highway commissioner.

Convict Labor Laws

All male prisoners, both felony and misdeameanor, with the exception of such as may be considered dangerous or desperate, are employed on the State convict road force. Practically the entire force is employed on the construction and maintenance of the State highway system.

Automobile Registration

The law provides for annual registration with the secretary of the commonwealth. The fee for registration, license and tags is 60 cents per horsepower. One-half of this is charged after September 1 of each year. Two-thirds of the fund thus created is applied to the maintenance of the State highway system, and the balance is applied toward meeting the Federal aid.

Highway Funds

Funds for the construction of roads included in the State highway system are derived from a direct legislative appropriation, a special levy of 1 mill on the dollar, and one-third of the automobile license tax, together wih the labor of the State convict road force. Any part or all of these resources may be issued to meet the Federal aid.

Funds for State aid are derived from a direct legislative appropriation which, as already stated, must be met by an equal amount of county or district funds. The State aid appropriation may be applied to either new construction or to the maintenance of improved roads included in the county system.

Two-thirds of the automobile license tax is used for the maintenance of roads included in the State highway system and any part of the labor of the State convict road force which the State highway commissioner may consider necessary may be used for that purpose.

For the fiscal year October 1, 1918, to October 1, 1919, the State highway work was financed with State funds as follows:

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Direct appropriation to meet Federal aid..	$425,000.00
Special three-tenths mill tax.....	373,711.50
Receipts from automobile tax for maintenance of the State road system.....	547,359.42
Appropriation for State aid which had to be met by an equal amount of county funds	300,000.00
Total	$1,646,070.92
To this should be added 2,542,472 hours convict labor on the State highway system at 20 cents per hour, amounting to.	512,494.40
Total of State funds, including the value of prison labor.....	$2,158,565.32

For the current fiscal year, October 1, 1919 to October 1, 1920, the State highway work will be financed with State funds as follows:

Receipts from special 1-mill State-wide tax	$925,000.00
Special appropriation	85,000.00
Receipts from automobile fund for construction	450,000.00
Receipts from automobile fund for maintenance	900,000.00
Appropriation for State aid.....	400,000.00
Total	$2,760,000.00
Value of prison labor to be performed about	500,000.00
Total of State funds, including the value of prison labor.....	$3,260,000.00

Estimated Mileage and Cost Per Year Ending September 30, 1919

	Cost Including Supervision	Total	Mileage	Total
Construction State highway system.....	$1,084,876	.....	95.2	.....
Construction State-aid.....	1,024,248	$ 2,109,124	212.0	307.2
Maintenance State highway system.....	810,774	.....	1,453.9	.....
Maintenance State-aid roads.....	418,236	1,229,010	2,063.7	3,517.6
Total.....	.....	$ 3,338,134	.....	.....

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State Highway Officials

State highway commision: Wade H. Massie, chairman; James S. Mundy, member; H. P. Beck, secretary; Horace Hardaway, member; Frank W. Davis, member. G. P. Coleman, State highway commissioner; Wm. F. Cocke, assistant commissioner; Dudley McDonald, second assistant commissioner; B. Atkins, chief clerk; S. L. Von Gemmingan, engineer of construction and maintenance; F. D. Henley, engineer of State aid; C. S. Mullen, district engineer; northern district; A. H. Pettigrew, district engineer, southern district; Wm. R. Glidden, bridge engineer; C. L. Gizycki, engineer of plans and estimates.

Prepared by Wm. F. Cocke, assistant commissioner.

WASHINGTON

State Aid Legislation

The construction and maintenance of State roads is under the direction of the State highway commissioner, appointed by the governor for a term of four years. The State highway board, which consists of the governor of the State, the State treasurer, the State auditor, a member of the Public Service Commission, named by the governor, and the State highway commissioner, who acts as secretary, apportions the amounts appropriated by the legislature to the various counties, awards contracts and decides matters of general policy in connection with the work of the State highway department.

A system of primary and secondary State roads has been established by the legislature. Primary State roads (2,112 miles) are built by the State and maintained by the counties under State regulation from funds apportioned by the State from the motor vehicle revenues. Secondard State roads (1,181 miles) are built by the State and maintained by the counties. The legislature makes appropriations from the public highway fund, raised by a State-wide tax of 1 mill, for construction of designated portions of the State roads, and for the maintenance of the State highway department. About $1,000,000 annually is also appropriated for the construction of State roads from the motor vehicle revenue.

The permanent highway fund is derived from a tax of 1.5 mills on all property; is paid into the treasury and credited to each county in the full amounts paid by such county. It is expended on contracts for surfaced road construction, under certain statutory restrictions. Road improvement under this law may be initiated by the board of county commissioners on its own motions when the entire cost of construction, except engineering super-

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vision, is paid from the fund; or it may be initiated by a petition signed by the owners of not less than two-thirds of the property fronting on the section of the road to be improved, in which case at least 15 per cent of the cost is assessed to the abutting property. Plans and specifications for such work are prepared by the county engineer, subject to the approval of the State highway commissioner, who must approve all payments made for such work and examine and accept the completed contracts. The expense of the county engineer in connection with these improvements are paid from the general county funds, those of the State commissioner from his office appropriations. Five per cent of the fund is set aside for the maintenance of roads constructed under the provisions of the act.

Federal Cooperation

Under the Federal-aid road act of 1916, 14 projects, covering 76 miles, were approved prior to 1919 and construction had proceeded upon 8 of them to the extent of about $500,000. Up to date (July, 1919) about 30 additional projects have been approved to the extent of about $3,000,000.

Local Road Laws

The roads of a county, not under the township system, are in charge of the board of county commissioners. The board divides the county into districts and appoints a supervisor for each. A county engineer is elected biennially. Two counties have adopted the township system, and their roads (except State and county main roads) are under the commissioners or supervisors of each township.

Local Bond Legislation

There are in Washington three operative statutes passed and effective in the years 1890, 1893 and 1913, respectively. The last two are very similar, and the act of 1913 is intended to confer additional power and authority. Bonds may be issued under the provisions of either of these statutes.

By the law of 1890 the boards of county commissioners submit to an election the question of issuing sinking fund coupon road and bridge bonds in an amount not to exceed 5 per cent of the taxable property in the county, bearing not over 6 per cent interest and payable at such time as may be fixed by the board of county commissioners. A vote of three-fifths of the ballots cast is necessary to authorize the issue. The county commissioners must levy annually sufficient tax to pay interest and create a sinking fund to redeem them at maturity.

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By the act of 1893 the county commissioners are authorized to construct a system of improved roads and to call an election on the question of issuing bonds to pay for them. If three-fifths of those voting are favorable the commissioners issue the bonds, which are made payable within 20 years, bear not exceeding 6 per cent interest and in an amount not exceeding 1½ per cent of the value of taxable property therein. The county commissioners are required annually to levy and collect a tax sufficient to pay the interest and, in case they are to run longer than 10 years, they shall annually levy and collect, beginning with the annual tax levy succeeding the expiration of 10 years from the date of the bonds, an additional tax to provide a sinking fund for the payment of the principal. This annual sinking fund levy shall be at least equal to 10 per cent of the amount of the bonds outstanding.

The 1913 act authorizes the board of county commissioners of any county to submit to the voters the question of issuing bonds and an affirmative vote of three-fifths of the ballots cast is necessary to authorize the bonds. They must run not to exceed 20 years and bear not over 6 per cent interest. The provisions of this act apply not only to roads which are under the general control of the county, but also to State roads in the county and to roads within the limits of an incorporated city or town, provided they form a part of the public highway system of the county, and provided further that no proposition for bonds shall be submitted which proposes that more than 40 per cent of the proceeds shall be expended within any city or town or within any number of cities and towns. The county commissioners must levy an annual tax sufficient to pay the interest, and at least 5 years prior to the maturity of the bonds and thence forward a tax sufficient to retire the bonds at maturity.

Convict Labor Law

Able-bodied State prisoners, not engaged in other work required by the State board of control, may be employed upon the public highways under the direction of the State highway commissioner. All expense of care, maintenance and transportation above 25 cents per day for each convict is paid from the funds authorized for road being improved. This fund is also charged 25 cents per day for the maintenance of the penitentiary.

In 1909 five State quarries were established to be operated by convict labor. The material prepared at these quarries was used on State roads and was available for any city, town or county after the State road requirements were met. The sale of any

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excess production after State and municipal needs were satisfied was authorized at a price of not less than 10 per cent above the estimated cost of production at place of delivery. These quarries were operated for a few years, but three were closed because their product was not needed and on account of shortage of convict labor following prohibition. Under the law of 1911 they were offered to the counties where located and two were accepted and are now being operated with free labor.

County commissioners may order jail prisoners to work on the public roads under direction of the sheriff at a distance of not to exceed 5 miles from place of detention.

While the law for prison labor remains unchanged, the number of convicts available for road work has decreased to such an extent since the prohibition law went into force that there has been no road work by prison labor during the past two years, and none is likely under the present outlook.

Automobile Registration

Application for a motor vehicle license is made to the county auditor and is forwarded to the Secretary of State, who issues a license and number plates.

The annual license fees are based on weight and capacity and are as follows: All motorcycles, $6; automobiles for private use, 1,500 pounds or less, $10; 1,500 pounds or more, $10, and 60 cents per hundredweight for all over 1,500 pounds; automobiles for hire, 1,500 pounds or less, $20, plus $3 per passenger capacity; over 1,500 pounds, 60 cents per hundredweight additional; auto stages, 1,500 pounds or less, $25, plus $3 per passenger capacity; over 1,500 pounds, 60 cents per hundredweight additional; auto stage trailers, 1,500 pounds or less, $10, plus $3 per passenger capacity; over 1,500 pounds, 60 cents per hundredweight additional; motor trucks weighing 1,500 pounds or less, $10; weighing 1,500 to 6,500 pounds, $10, plus 40 cents per hundredweight for all in excess of 1,500 pounds; weighing over 6,500 pounds, $10, plus 50 cents per hundredweight for excess over 1,500 pounds; trailers used as trucks, truck rates; dealers in motorcycles, $10; dealers in demonstration motor vehicles, regardless of weight, $50; additional dealers' plates bearing same number, $10.

The costs of administration of the law are paid from the receipts of fees. One million dollars of the fees and all fines are paid into the permanent highway maintenance funds of the counties, and of the remainder of the revenue, $1,000,000 to $1,250,000 is annually appropriated for State highway construction.

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Road Funds

The 1919 legislature appropriated $4,241,500 for State roads for the two years ending March 31, 1921, and reappropriated $619,844 for that purpose; it also appropriated $4,000,000 for permanent highways. It is estimated that $10,000,000 of county funds will also be spent during the next two years.

Progress Report

Fund available in 1919 (including "holdovers" from 1917-18:

Federal funds (post roads and national forest roads)	$ 825,000
State funds (public highway, permanent highway, motor licenses	4,175,000
County funds, 39 counties (county road and bridge, road districts, special improved districts, county bonds)	7,000,000
Total	$12,000,000
New construction program for 1919:	
Federal administration: National forest roads	$ 500,000
State highway department: Federal-aid post roads and State highways	2,000,000
County administration: Permanent highways and other main county highways, district roads, bond roads	5,500,000
Total for new construction	$8,000,000
Maintenance program for 1919:	
County administrations (under State regulation): 1,800 miles of primary State highways	$ 750,000
County administrations: 800 miles county permanent highways, etc	250,000
40,000 miles tributary, local district roads	3,000,000
Total for maintenance	$4,000,000

On July 30, when this report was prepared, about two- thirds of the 1919 program was already under way.

Under contract during 1918.	Amount.
Grading 105 miles	$1,786,400
Grading and shoveling 207 miles	2,787,730
Gravel-surfacing only 40 miles	147,000
Bridges, 11 only	793,218
Pavements, 73 miles	2,519,800

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State Highway Officials

Governor Louis F. Hart, chairman; James Allen, State highway commissioner, secretary; W. W. Sherman, State treasurer; C. W. Clausen, State auditor, and F. R. Spining, member of the Public Service Commission.

Headquarters, Olympia, Wash.

Revised by James Allen, State highway commissioner.

WISCONSIN

State Aid Legislation

The State highway commission is composed of five members, two being ex-officio members, viz., the dean of the college of engineering of the State University and the State geologist. The three other members are appointed, one every two years, by the governor for terms of six years. They serve without compensation, except actual expenses.

The State highway engineer, under whose immediate direction the road work is carried on, is appointed by the State engineer with the approval of the State highway commission.

There are two systems of roads to which the State contributes aid, viz., county systems of prospective State highways, consisting of about 20,000 miles selected by the county boards with the approval of the State highway commission for improvement with State and local funds, and State trunk highways, comprising 7,500 miles connecting county seats in important towns and selected by the State legislature.

Prospective State highways are constructed by the county, town and State jointly, or by the county and State jointly. In the former case the town, county and State each pays one-third of the cost. In the latter case the county pays three-fifths and the State two-fifths. This applies to both road and bridge construction.

State trunk highways are constructed under the supervision of the State highway commission with funds provided by the Federal government, State and the counties. A county may assess a portion of the cost, not exceeding 4 per cent of its share, on the towns or town benefited by the improvement. State trunk roads are maintained by the counties under the supervision of the State highway commission.

Under the statute assenting to the Federal-aid law, the State highway commission in 1917 selected a State trunk highway system of 5,000 miles, which was increased to 7,500 miles in 1919. All improvements with Federal aid must be made on this system.

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The joint Federal and State fund is alotted to the counties, one-third in proportion to area, one-third in proportion to valuation, and one-third in proportion to total road mileage. The counties are required to pay one-third of the cost of construction of roads built with Federal and State funds. Federal-aid construction is performed directly by the State, generally by contract.

When the State trunk highways are maintained by the counties, in accordance with the regulations of the State highway commission, the counties are reimbursed for the cost by the State. Usually the actual work of maintenance is performed under the patrol system, the patrolmen acting under the direct instructions of the county highway commissioner.

All portions of the State highway system are marked by a standard design which is uniform on all roads of the system with the exception of the number, which varies for each route and corresponds to the number shown for that route on the State highway commission's official map. Suitable guide and warning signs have also been erected on all parts of the State system.

Local Legislation

General jurisdiction over all roads other than those on the county system of prospective State highways and the State trunk highway system in each town is in the hands of the town, consisting of three members, all elected annually, or one member each year for a term of years.

The county board of each county, composed of a supervisor from each town, elects a county highway commissioner who is in charge of all construction and maintenance work, except that the county committee selected by the board acts as a board of directors jointly with the State highway commission in the general control of the work in each county.

The county boards may determine that the town boards shall be elected for terms of three years with the term of one member expiring each year.

The legislature of 1919 enacted a statute providing for cash payment of all road taxes and the execution of all town road work under the direct supervision of a single town superintendent of highways.

Bond Legislation

Any county, through its board, may issue non-taxable coupon bonds bearing interest at 5 per cent, payable semi-annually and to run not to exceed 10 years, for the original improvement of any portion of the system of prospective State highways. The bonds may not be sold outside of the county until the residents

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of it have had a reasonable opportunity to purchase them, and when sold, the proceeds must be apportioned by the county board. The form of the bonds must be approved by the State highway commission.

The bonds are to be divided as to denominations and due dates so as to have an equal amount payable each year. The interest and principal are provided for by direct tax to be assessed by the county board. Provision is also made for the issuance of bonds conditioned upon the payment of all interest by private subscriptions, but money or approved securities must be first deposited to secure the payment of this interest.

County bonds may be issued at any one session of the board in an amount not exceeding two-fifths of one per cent of the assessed valuation of all taxable property in the county. This may be increased by the action of subsequent county boards, but the total amount of bonds so issued or outstanding at any one time must not exceed one per cent of the total assessed valuation. A proposition for the issuance by any county board of bonds in excess of two-fifths of one per cent of the assessed valuation of the county must be submitted to and adopted by vote of the people.

Town bonds may be issued for the original improvement of any portions of the system of prospective highways in a manner similar to that of the county, but the proposition must, without exception, be submitted to a vote of the qualified electors of the town. The issuance of these bonds is conditioned on the county issuing bonds to a like amount. Town bonds are not available for State aid.

Convict Labor Laws

Convicts in county jails may be used in quarrying stone for road work. Convicts in the State prison may also be used in the construction of roads. The employment of convicts on State roads is optional with the counties.

Automobile Registration

The law provides for annual registration with the Secretary of State, with the following schedule of fees: Motorcycle, $4; passenger cars, $10; dealers and manufacturers, for each garage, $25; trucks, 2,100 pounds or less, $15; 2,100 to 5,100 pounds, $20; 5,100 pounds and over, $25.

Road Funds

One-fourth of the net registration revenue collected by the Secretary of State is returned to the county from which it is

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collected at the end of each year for the maintenance of the county system of prospective State highways. An amount not to exceed $168,000 per year is then set aside from the balance as an administration fund for the State highway commission. The remainder is used for construction and maintenance of State trunk highways. This fund, exclusive of the one-fourth returned to counties, amounts to about $1,500,000 annually.

In addition to this an annual appropriation was made by the legislature for the fiscal years 1917 to 1919, inclusive, of $785,000, to be allotted to the counties for State-aid construction. Allotments to counties are made in the ratio that the assessed valuation of each county bears to the total assessed valuation of the State.

An annual appropriation amounting to $80,000 is also made by the legislature from general funds to defray the expenses of operation of the State highway department in the administration of the State-aid law. The State had at its disposal during 1919 exclusive of Federal aid and local contributions, $2,365,000.

The 1919 legislature provided that a State tax should be levied for the three years beginning July 1, 1919, which would produce $1,700,000 a year for State aid and to meet allotments of Federal aid. The rate necessary to produce this total will approximate one-half of a mill.

Progress Report

In addition to carrying out a large construction program, this State, through the counties, is maintaining its entire trunk highway system of 7,500 miles, the unimproved portions as well as the improved portions. These roads are systematically dragged and planed and are in a very good condition for travel throughout the summer months.

State Highway Officials

Wisconsin Highway Commission, Madison: J. A. Hazelwood, chairman, Jefferson; W. O. Hotchkiss, State geologist, Madison (ex-officio); F. E. Turneaure, Madison (ex-officio); John S. Owen, Eau Claire; Fred Pabst, Oconomowoc.

A. R. Hirst, State highway engineer; M. W. Torkelson, bridge engineer; H. J. Kuelling, assistant engineer; J. T. Donoghey, maintenance engineer; Geo. C. Hank, chief clerk.

Revised by M. W. Torkelson, bridge engineer.

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WEST VIRGINIA

State Aid Legislation

The legislature of 1917 established a State road commission consisting of two members, one to be a civil engineer and one a practical business man. They are appointed by the governor for terms of four years by and with the advice and consent of the Senate. One member of the commission acts as chairman and the other as secretary-treasurer.

For the purpose of administration the State is divided into 5 divisions, each in charge of a division engineer. He, with his assistants, prepares plans and supervises construction of class "A" roads.

The commission has supervision over all main county or class "A" roads, which comprise 4,556 miles, selected by the county courts of each county subject to the approval of the State highway commission, and including two or more main roads in each county connecting with similar roads in other counties.

State and Federal aid is granted by the commission to the counties on the basis of the percentage of class "A" roads. This money must be met by a like sum from the county to be used for certain definite projects. Plans and contracts for these projects are under the direct supervision of the State road commission.

The improvement of class "A" roads is executed by the counties, subject to supervision by the State commission or its authorized agent. They are maintained by the counties with county funds.

Local Legislation

County, road and bridge administration is vested in the county court, composed of three or more elective members designated as judges. The court must appoint a county engineer, who has direction of State and county work in the county.

The county court has power to fix and levy taxes and to enter into contracts for road and bridge improvements. District levies are limited to 25 cents on the $100 and county levies for class "A" roads to 35 cents.

Bond Legislation

At the 1919 session of the legislature an act was passed authorizing a popular vote on a $50,000,000 State bond issue. This proposition will be voted upon in November, 1920, and if authorized the proceeds will be used in the construction of class "A" roads. These bonds are to be retired with funds derived from a State-wide tax.

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The county court may improve the main roads of a county and pay for them by the issuance of county bonds. Bonds can be issued only upon petition of the voters of the district or county, and approval of the proposition at a general or special election by three-fifths of all votes cast. The bonded indebtedness outstanding at any one time is limited to 5 per cent of the value of the taxable property within the county, and the interest shall not exceed 6 per cent. In like manner the county court may issue road bonds of any magisterial district within a county.

Convict Labor Laws

Circuit, criminal and justice courts shall sentence convicts to work on roads under the county court or its engineer. The county court may apply to the State board of control or State road commission for State prisoners to work on the highways of a county.

Automobile Registration

Automobiles are registered by the State road commission, the fees being as follows: Automobiles weighing 2,000 pounds or less, $10, plus 25 cents for each additional 100 pounds. The rate for pneumatic-tired trucks is the same as for passenger cars. The rate for solid-tired trucks weighing, without load, 2,500 pounds or less, of one ton capacity, is the same as for passenger cars.

In addition to the above registration tax, there is also a special privilege tax placed upon all commercial vehicles operated outside of cities and towns. The rates are fixed by the State road commission and vary from $15 to $200 per annum for vehicles having a carrying capacity of from 1 to 7 tons and over.

There is also a personal property tax on all automobiles, so if one operates a commercial vehicle he must pay three taxes, registration, special privilege, and personal property.

Road Funds

The only State funds available are those derived from the net receipts from the registration of automobiles and special privilege taxes on automobiles, which at present, amount to about $1,000,000 annually. This does not include the personal property taxes on automobiles which go into the general funds of the counties. The automobile fund, together with Federal aid, constitutes the State road fund and is expended on class "A" roads, the counties providing an equal amount raised by local taxation or bond issues.

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Progress Report

Out of 32,000 miles of public road in the State, 698 miles have been improved outside of incorporated cities and towns including the following: Brick 180 miles, bituminous macadam 144, concrete 133, waterbound macadam 162, other types 79 miles.

The State highway commission estimates that on August 1, 1919, the various counties had available for expenditure on roads, derived principally from bond issues, approximately $9,000,000 and that additional bond issues contemplated in the various counties approximated $8,000,000.

There were on that date 70 Federal-aid projects under way in the State, involving $1,400,000 of the $1,800,000 Federal aid available. There was also under way 81 State-aid projects.

State Highway Officials

C. P. Fortney, chairman; Julius K. Monroe, secretary-treasurer, Headquarters, Charleston.

Revised by F. P. Arnold, assistant engineer.

WYOMING

State Aid Legislation

The State highway department consists of a State highway commission of five members, and a State highway superintendent. Commissioners are appointed by the Governor for terms of six years, the terms of two commissioners expiring biennially. The commissioners receive a salary of $600 per year each and actual expenses. The State highway superintendent, who must be experienced and skilled in highway and bridge construction and maintenance, is appointed by the commission for an unlimited term. His salary is fixed by the commission.

The commission is authorized to designate, construct, and maintain at the expense of the State, a system of State highways, and has to date taken over approximately 2,000 miles. Federal aid funds may be applied by the commission to this system. On practically all the work thus far undertaken 50 per cent of the cost has been borne by the Federal government and 50 per cent by the State.

The commission is authorized to co-operate with counties and the Federal government in the construction of roads within, or partly within National forests, in accordance with section 8 of the Federal Aid Road Act. The highway department also co-operates with counties in the construction and maintenance of county roads not included in the State system, furnishing plans,

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specifications, etc. The state and the county each pay 50 per cent of the county roads, cost of construction, the county paying the entire cost of maintenance. Plans and specifications for all bridges in the State constructed by counties or cities costing $1,000 or more are prepared by the State highway superintendent, whose approval must be secured before any payments can be made on their construction.

Local Road Legislation

The county commissioners have charge of all county roads. Each county is divided into road districts and a supervisor is elected for each district who is under the direction of the county commissioners. The county road and bridge funds are obtained from a tax at a rate of not to exceed 3 mills on the dollar on all taxable property in the county, a $2 poll tax and 25 per cent of the revenues collected by the United States Forest Service, which is distributed among the counties in which the reserves are located.

Bond Legislation

On April 22, 1919, by popular vote, the State authorized $2,800,000 of road improvement bonds for use on State highways. These bonds bear not to exceed 5 per cent interest, are callable after 10 years, and are payable 20 years from date. Under the direction of the State Board of Equalization, boards of county commissioners from the various counties are required to levy sufficient tax each year to pay the interest and, after the tenth year, a tax sufficient to redeem one-tenth of the bonds in such series then outstanding until the bonds are retired.

The State constitution authorizes counties or subdivisions thereof to create indebtedness not to exceed 2 per cent of their taxable valuation, but there has been no statutory enactment, either general or special under the authority conferred for the issuance of local road bonds.

Convict Labor Laws

Any convict may be put to work on roads and streets. To date convicts have been used only on jobs where it is difficult to place the work under contract.

Automobile Registration

Motor vehicles are registered with the Secretary of State on the basis of 40 cents per h. p., for passenger cars; 75 cents for each 100 pounds, or major fraction thereof on trucks and trailers; and $5 on each bicycle or motorcycle. Dealer's license fees amount to

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$50 per annum. These fees are credited to the State sinking fund for the purpose of paying interest and principal on State highway bonds.

Road Funds

The funds derived from the bond issue of $2,800,000 are available until expended for construction of State highways. Seventy-five per cent of the fund over and above overhead expenses are apportioned to the various counties on the basis of assessed valuation. The balance is expended on State highways at the discretion of the commission.

The 1919 legislature appropriated $300,000 made immediately available February 28, 1919 and $300,000 available March 1, 1920. These funds will be available until expended without additional appropriation for the construction of State highways, the money to be apportioned among the counties on the same basis as the State bond funds.

Progress Report

A decided improvement was made in the condition of the State highways during 1919, due to maintenance work started in June. The funds available for 1920 are not all that could be desired, but by spending them at points where work is most needed, and maintaining the better stretches of road just as they exist, the State commission hopes to make a decided impression.

State Highway Officials

M. R. Johnson, chairman, Wheatland, Wyo.; Joe C. Kinney, Cokeville, Wyo.; W. R. Weeks, Lander, Wyo.; L. E. Baird, Worland, Wyo.; L. R. A. Condit, Barnum, Wyo.; D. S. McCalman, State highway superintendent, in charge of the administrative work of the department.

Revised by D. S. McCalman, State highway superintendent.



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HIGHWAY IMPROVEMENT IN CANADA

Roads in Canada are under the legislative jurisdiction of the nine Provincial governments, each of which has an independent highway department, or one associated with a Provincial department of public works. Legislation has tended to convey to local municipalities a large measure of responsibility for road control; exceptions to which, however, are the small Provinces of Nova Scotia and Prince Edward Island, in which roads are principally under Provincial control.

The Dominion (Federal) Government in July, 1919, adopted "The Canadian Highway Act" appropriating $20,000,000 to be granted to the Provinces in aid of highway improvement in a period of five years. The grants under this act are to be limited to work carried out under an agreement with each Province, and subject to suitable regulations; the Province to guarantee maintenance of the work. The regulations governing the work have not yet (November, 1919) been finally adopted by the Dominion authorities, so that no work has yet been carried out under the Dominion act.

The total length of roads in Canada has not been accurately surveyed, but is estimated at 250,000 miles.

ONTARIO

By W. A. McLean, Deputy Minister of Public Highways

Road mileage, 55,000.

Public highways in southern Ontario are under the control of (*a*) the department of public highways; (*b*) county councils; (*c*) local municipal councils (townships, villages, towns, or cities).

The department of public highways under a minister and in charge of a deputy minister, chief engineer and staff exercises supervision over all highways and bridges towards the cost of which a provincial contribution is made.

The department also acts in an advisory capacity towards municipalities requiring technical assistance.

The county council exercises jurisdiction, under the inspecting supervision of the department, over roads assumed by them for improvement with the aid of the provincial contribution.

The local municipalities exercise complete control over roads within their respective limits which have not been assumed for improvement either by the Province or by one of the counties.

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In accordance with the above scheme of jurisdiction, the department of ways in Ontario is divided into the following classes:

(*a*) Provincial highway system. This is a system of main roads, running from Windsor to the Quebec Boundary, passing through London, Hamilton, Toronto, Kingston, Brockville and Prescott, and with branch lines from Hamilton to Queenston and from Prescott to Ottawa.

This system when complete will serve not only as a means of carrying arterial traffic through the Province but will also serve as a ready means of ingress into Canada for the touring public of the United States. The success of its services depends, however, upon the extent to which it is fed by the roads of more local importance, thus furnishing together with its feeders a channel of traffic between large centers of population and the most outlying farming districts. Towards the cost of construction and maintenance of this system the Province contributes 70 per cent.; municipalities through which a section of road runs pay 30 per cent. Cities and large towns, the roads in the vicinity of which are under the jurisdiction of a special commission, contribute the 30 per cent.

Considerable progress was made during the season of 1919 on the Provincial highway, operations consisting of grading, ditching, constructing of concrete culverts and bridges, securing adequate right of way, and maintaining the existing road surface.

(*b*) County roads. These are roads within a county assumed by the county council for improvement under Provincial aid to the extent of 40 per cent. of the cost of construction and maintenance. The work is performed under the supervision of the county road superintendent by direction of the county council and approval of plans, specifications and accounts together with inspection of the work by the department of public highways as a necessary preliminary to the Provincial grant.

Certain county roads considered by the department to be of more than local importance are designated by the minister as Provincial county roads, towards the cost of construction and maintenance of which the Province pays 60 per cent.

Suburban roads radiating from cities, under the jurisdiction of a special commission when they do not form part of the Provincial highway system, are financed to the extent of 40 per cent. by the Province, the remainder of the cost being paid equally by the city and the county.

At present 36 counties in Southern Ontario have taken advantage of government aid for county roads. Provincial subsidies for these amounted in 1918 to $815,439.99 of which

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$604,245.01 was for construction and $211,194.98 for maintenance. The total mileage surfaced during that year was 215 miles, while 321 miles were graded, 92 bridges and 898 culverts were constructed.

(*c*) Roads under local municipal authority. These include not only the streets of cities, towns and villages, but all township roads which have not been assumed by the Province or by the counties for improvement or maintenance. These township roads, it is estimated, constitute 80 per cent. of the total road mileage of the province and carry only 20 per cent of the traffic. With this large mileage of rural road surface to be accounted for, the policy of the department must be to adjust highway improvement to traffic needs, encouraging the placing of roads used to a considerable extent in the hands of authorities, such as county councils able to finance careful maintenance and suitable construction; and on the other hand to keep the roads under township jurisdiction in a fair state of maintenance. For this latter purpose the department contributes an amount up to $150 per year towards the salary of a township road overseer for any of the 416 townships in Southern Ontario. The total township council expenditures on roads amounted in 1917 to $1,615,790. War conditions have had a considerable effect upon township expenditures, a notable effect being a decrease for the whole Province of nearly $1,000,000, from 1914 to 1915. In 1914 the figure stood at $2,615,137.

The department of public highways controls the revenue from motor vehicle permits and chauffeurs' licenses which amounted in 1918 to $1,214,093.87. The number of motor vehicles in the Province in 1918 was 101,845 passenger cars, 7,529 commercial cars, and 5,002 motorcycles.

Apart from highway improvement under the department of public highways in southern Ontario, the government has spent some $5,000,000 on trunk colonization roads in Northern Ontario and on the local roads in the sparsely settled townships among the Muskoka Lakes and eastward to the Ottawa River.

QUEBEC

By B. MICHAUD

Deputy Minister of Roads

1. *Organization of the department of roads.*—The personnel is as follows: minister, deputy minister, officer-at-law, chief engineer and assistant, 3 engineers and their assistants in charge of districts (the 3 districts comprise 22 divisions, each of which

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is in charge of an engineer or an inspector), 2 engineers for designing concrete culverts and bridges, 5 other engineers entrusted with different works at various points, one superintendent of Provincial roads and road machinery (including store for repair parts), accountant and auditor. With the assistants, clerks, draughtsmen, stenographers, etc., attached to the officers named, the staff of the department of roads aggregates 97 officers and employes, apart from the inspectors on the roads.

The chief engineer has the direction of the laboratory for test of stones, cements, gravels, and asphalts. Under the control of the chief engineer the district engineers are entrusted with the supervision of all the work in their sections. Such supervision comprises, (a) preliminary inspection of the road to be improved, that is a complete survey with, if necessary longitudinal profiles and cross sections showing all fills, cuts, concrete bridges or other works to be built, together with the location of material available, (b) preparation of plans and specifications based on preliminary inspection, and draft of estimates according to information gathered, (c) thorough and constant inspection of the work under way, by personal attendance and through a staff of engineers or inspectors.

2. *Type of Roads.*—Types of roads have been and will be, whenever opportune, asphaltic concrete, cement concrete, bituminous macadam, water-bound macadam and gravel roads. No such road has been built or will be built before thorough consideration has been given to grading and drainage, in accordance with the best methods. Drainage is carried out by construction of ditches, culverts, bridges, French drains, tile drains, etc., etc.

Macadam.—No macadam is built before the subgrade has been properly shaped and brought to camber of the paving proper. This is done by using the 12-ton steam roller, filling the depressions and rolling over again till perfect settlement is obtained. (The subgrade prepared in view of laying out a concrete road is not crowned but left flat.) No macadam is built without a foundation not less than 6 inches, except in case of a concrete pavement; in this case, a sand cushion is often laid out when required on account of the nature of the soil. Over the foundation, a second course of foundation is laid. (This second course of foundation has been heretofore called the first course of macadam.) The second course of foundation is 4 inches thick before rolling. So is the top course which is filled with screenings and sprinkled till perfectly bound. These three courses are thoroughly packed, separately, with the steam roller, and properly crowned, according to camber adopted.

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Asphaltic Concrete.—The asphaltic concrete we use is the mixture known as topeka, which has been improved by devising a closer and more accurate grading of the metal screenings and filler.

Cement Concrete.—The cement concrete is a mixture of 1:2:4, without reinforcement. The pavement is laid flat, with a thickness ranging from 7½ to 8½ inches at the centre, and six to seven inches at the edges (16-foot pavement) with quarter-inch expansion joints every 25 feet.

Bituminous Macadam.—The bituminous macadam is the ordinary type built after the penetration method, the quantity of asphalt used being 1.65 imperial gallons per square yard, distributed with pressure machine (the 1.65 gallons include the seal coat).

Gravel Roads.—The road to be gravelled is prepared in the same manner as the macadam road as regards grading and draining. In some cases the gravel is put in a trench. In most cases it is spread over a width ranging from 16 to 24 feet, the thickness in the centre ranging from 12 to 16 inches.

Carpet Coats.—Carpet coats are laid on Provincial roads built in macadam. They are made by spreading with a pressure machine about ½ gallon per square yard of asphalt, which is afterwards covered with pea stone ranging from ¼ to ½ inch in size, at the rate of about 35 pounds per square yard. Sand is afterwards spread over to take care of the bleeding. Of course, no carpet coat is laid before the surface of the macadam has been previously smoothed and cleaned by means of mechanical sweepers and ordinary brooms.

The types of roads I have just mentioned are those adopted by the government for Provincial roads and ordinary roads.

3. *Classification of Roads.*—For improvement purposes we have two main classes of roads, namely: (a) Provincial roads; (b) ordinary roads. All these roads, Provincial or ordinary, remain municipal roads, that is, even if the government takes possession of a road in order to reconstruct it as a Provincial road, the road remains the property of the municipality within whose limits it is situated. The maintenance of the road is in the hands of the government, as will be explained hereafter.

Provincial Roads.—The government of the Province of Quebec has built five trunk roads (a sixth one is under construction) between important centers, namely: Montreal-Rouse's Point, 38 miles, waterbound macadam with carpet coat; Montreal-Quebec, 159 miles, waterbound macadam partly with carpet coat, except 10 miles of cement concrete, 9.8 miles of asphaltic concrete, and 0.6 mile of bituminous macadam; Sherbrooke-Derby Line, Vt., 30

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miles, gravel, except 6.3 miles of tarvia penetration; Chambly, (connecting Montreal and Federal Road at St. Johns), 15 miles, waterbound macadam of which 3.7 miles are covered with a carpet coat; Levis-Jackman, Maine, 95 miles, gravel. The sixth Provincial road is between Three-Rivers, Shawinigan and Grand 'Mere, about 25 miles. These roads have been built by the government or under the government's supervision, the interested municipalities contributing to the cost in various proportions.

Ordinary Roads.—These are the roads built or improved by the municipalities in virtue of by-laws passed by their municipal councils. These by-laws cannot be passed in view of securing a government grant or allocation unless they contain specifications drawn up by the department of roads. As a matter of fact the ordinary roads are constructed under the same specifications and supervision as those built by the government itself. They are called ordinary roads for the sake of distinction between the Provincial roads which connect important centers and are of general interest, and the roads of local interest. Such distinction is bound to appeal to those who have a clear idea of the needs of our country; extensive intercourse by means of Provincial roads and local communication by means of ordinary roads.

In granting moneys to municipalities towards the construction of ordinary roads, the government is always careful as to the selection of the most important roads. The type of road is also selected to fit the traffic in each case. For instance, special attention is given to roads leading to stations. Even in the construction of these ordinary roads, the government has constantly in view the development of continuous stretches, which, in time, are bound to constitute trunk roads, similar in some cases to the Provincial roads already built. The government gives special facilities to municipalities which unite together for the purpose of linking their roads, and thus achieving some of those stretches. Towards that end, the so-called Good Roads Act of 1911 authorizes the minister of roads to grant a special subsidy over the ordinary 50 per cent to a municipality that macadamizes a road crossing it through its whole length.

The construction of trunk roads by municipalities is well under way. In the near future quite a number of those roads will have been constructed between Sherbrooke and Beauceville, connecting Sherbrooke and Quebec, by way of the Levis-Jackman Road; between Sherbrooke and Montreal, Sherbrooke and Thetford Mines, Levis and Fraserville, Chicoutimi and Roberval, etc., etc.

4. *Government Aid Towards Road Construction.*—As already said, Provincial roads have been built and paid by the

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Government out of the $20,000,000 hereafter referred to, municipalities contributing certain small amounts. To municipalities towards the construction of ordinary roads, the government grants: (a) money at 3 per cent; (b) money at 40 per cent and 50 per cent.

(a) The Goods Roads Act, 1912, authorizes the government to borrow $20,000,000. Allocations to municipalities are made out of this fund. These allocations cover the whole amount required to carry out the work contemplated. For instance, if a municipality needs $100,000 to build 10 miles of roads, the $100,000 is supplied to such municipality, which on this amount is bound to pay to the government 3 per cent interest during 41 years. The balance of the interest and the sinking fund are paid by the government. In certain cases, cities and towns are granted the benefit of the act.

(b) Each year, an appropriation is made in the estimates towards the improvement of rural roads. Last year's appropriation was $400,000. Out of it are paid administration expenditures and various subsidies towards construction. To villages, 40 per cent of the amount expended is paid, to other municipalities the grant is 50 per cent. A refund of one-third is also paid for the construction of culverts. Towns and cities are not entitled to these grants.

5. *Government Aid Towards Road Maintenance.*—Provincial Roads.—These are maintained directly by the government, which charges 50 per cent of the amount expended to the municipalities traversed by the roads. The maintenance is done by patrolmen under the supervision of a superintendent.

Ordinary Roads.—To each municipality, where roads have been macadamized or gravelled, except towns and cities, an annual grant of 50 per cent, but not exceeding $400, is made for maintenance. In few cases, where traffic is very heavy, the government grants special aid over the $400.

Earth Roads.—An annual grant ranging from $200 to a maximum of $400, equal to 40 or 50 per cent, as may be the case, is made to villages or rural municipalities that take charge of the maintenance of their earth roads. The maintenance is under the supervision of the district engineers. The grant is paid provided, besides ordinary maintenance, a certain amount of permanent work is done each year. By permanent work is meant grading, shaping, digging the ditches, etc., etc.

6. *Condensed Facts.*

The total mileage of roads in the Province of Quebec is about 40,000 miles.

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Out of 1,089 rural municipalities, 544 have abolished statute labor. The number increases every year.

The total length of macadam or gravel roads, including Provincial or ordinary roads, is 2,564.75 miles.

One hundred and forty municipalities own a complete macadam outfit bought with money supplied by the government.

The department of roads owns 57 complete macadam outfits, and also 17 steam rollers, 7 tractors and other construction outfits, which are put at the disposal of the municipalities.

The Province of Quebec has 5 Provincial roads connecting Rouse's Point with Montreal, Quebec, Levis, and Jackman, in the State of Maine, Sherbrooke and Derby Line, in the State of Vermont, Montreal and St. Johns, P. Q. Another one is under construction between Three-Rivers, Sherbrooke and Grand'Mere.

The Province of Quebec has roads acts in virtue of which the government can build trunk roads between important centers, grant money to county or local municipalities, for building purposes, grant money towards the maintenance of macadamized, gravel roads or earth roads.

In virtue of an act relating to maintenance the government has the right to repair and maintain macadam or gravel roads at the expense of the interested municipality and to collect from this latter its proportion of cost.

In virtue of an act respecting main communication roads, the government can build and improve defective links of roads and collect the cost from the municipality whose territory is traversed by the road. The same act applies to maintenance.

The government itself maintains the Provincial roads through a regular organization of patrolmen, and has the right to collect half of the cost against the municipality whose territory is traversed by a Provincial road.

The Province has a thoroughly organized department of roads, with chief engineer and staff, who prepare and carry out standard specifications of every type of road.

The government of the Province of Quebec has expended for road improvement, since 1912, $18,988,660.77. This memorandum does not cover the work of 1919.

BRITISH COLUMBIA

By A. E. Foreman, Public Works Engineer.

The Province of British Columbia has approximately 14,600 miles of road open for traffic in the unorganized districts—namely, outside of incorporated municipalities. These roads have been constructed and are now maintained at the sole expense of the

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Crown. About 5,000 miles of the highways may be classified as main trunk roads, subject to a heavy mixed traffic of motor trucks, touring cars, ore wagons, lumber wagons, and the more ordinary traffic of farming communities. There are also about 5,000 miles of second-class road, which carry less volume of traffic, but which normally have to support the very heavy loads connected with mining, logging, and other industries. The remaining roads are generally merely roads of access, subject to little traffic, and which, though costly to construct, especially in the mountainous or heavily timbered sections, are generally fairly cheap to maintain. In addition to the roads proper—that is, roads for ordinary wheeled vehicles—there are over 8,000 miles of trail, many of which in course of time will be widened out and improved, so as to finally form a part of the highway system.

In connection with the Provincial highways, there are nearly 60 miles of bridges, of which nearly 3 miles are steel structures, built either purely for highway purposes, or built as composite highway and railway bridges, in association with one of the several railway companies. At least 13 miles of our bridges are timbered truss spans, the balance being timber trestles.

Within organized areas the Provincial government has given material assistance to the various rural municipalities in connection with the construction of the trunk roads, and particularly in connection with the laying of improved surfaces. The formulation of a definite policy for dealing with work of this nature is under consideration by the administration.

At the commencement of the fiscal year 1917-1918 a radical change was made in the conduct of the outside affairs of the Works Department. In place of the road superintendents formerly in charge in almost every electoral district, 8 district engineers, 2 of whom had previously been assistant engineers in the department, were appointed to take responsible control of the 8 engineering districts comprising 2 or more electoral districts, depending upon area, geographical location, etc. These engineers are capable, technically trained men and have had wide practical experience, and the reports submitted by them are based solely upon the individual merits of the case from an economic and engineering standpoint.

As assistants to the district engineers, 20 general foremen, several of whom had been former road superintendents, and 11 assistant engineers, with practical experience in handling men, were appointed to take charge of the work in one or, in a few cases, more than one electoral district.

Local foremen directly in charge of all local construction and

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maintenance work, being appointed on a daily wage basis during the working season only, are naturally subject to considerable change. As it is recognized that much of the success of the new mode of handling the work depends upon these local foremen, it may take some little time to procure the right men and educate them along the proper lines.

With the exception of a few bridge contracts and one or two contracts for clearing and grading, all the work was undertaken under the former system of day labor.

The total mileage of road and trails at present in unorganized districts is estimated to be 14,623 miles and 8,207 miles, respectively. As the mileage had been greatly increased during the past few years, the department must be prepared to spend an increasingly greater annual sum to properly maintain, particularly the main roads, in order to protect the initial capital outlay.

Of the 372,630 square miles in the Province, less than one-half of 1 per cent. is organized into municipalities and that part contains 86 per cent. of the total population. The mileage of roads and trails mentioned is thus practically all located in the 99½ per cent. of unorganized territory, which has a population of about 770,000. Hence in this respect this Province is materially different from most of the other Provinces. With its widely varying topographical and climatic conditions, physically it occupies a unique position in the Dominion, rendering the construction and maintenance of roads a difficult and proportionately expensive undertaking.

The public works department, which is responsible for the highways of the Province, is thoroughly alive to the necessity of further extending the highway system for the benefit, not merely of the Province, but for Canada as a whole. The necessity of intercommunication by road with the rest of Canada and with our neighbors to the south in the United States has given definite form to the plans. A very thorough inquiry is being made to determine beyond dispute as to what, from every point of view, will be the best route for a trans-Provincial highway, as far as it affects British Columbia.

There is a highway leading from Alberni, at the head of the Alberni Canal, Vancouver Island, down through Nanaimo to Victoria; thence by steamer to Vancouver; then south across the Fraser River and up the left bank of this river to Hope. Improvements to this road have been carried out from time to time, and there does not remain a great deal of work to be done to make this section a thoroughly first-class highway. At Hope it becomes necessary to cross the Coast range of mountains by one

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of three routes—either up the canyon of the Fraser River to Kamloops; up the Coquihalla Valley and down the Coldwater to Merritt, and thence to Kamloops; or up the Silver Creek Valley and down the Roche River to Princeton.

The Silver Creek route to Princeton, and its continuation, would be an excellent highway, but one which will require a considerable amount of work to complete. From Princeton to Cascade via Fairview, Greenwood, and Grand Forks is a good road, and the construction of approximately 30 miles of road from Cascade to Rossland was decided upon early in 1919. At this time a fairly good road was being used from Rossland to Nelson. From the latter point a ferry-steamer is taken to Kootenay Landing, and from Creston the remainder of the highway leading through Cranbrook, Waldo, and Fernie to Crownest is completed and will not be a difficult matter to improve.

With regard to the other roads of the Province, there is a heavily traveled road leading in a northerly direction from Ashcroft, through Clinton and Soda Creek, to Quesnel. From there the road to Fort George will require to be located and built, as the old route is not desirable. Within a very short time it would be possible to complete the road leading west from Fort George along the Nechako River to Fort Fraser; thence up the Endako River to Burnt Creek, and then down the Bulkley River to Hazelton.

The Provincial government has also a road leading from Waldo, near Fernie, up the Kootenay River to Columbia Lake, and thence along the Columbia River to Golden.

There is another projected highway known as the Banff-Windermere road, which is destined to link up the East Kootenays with Western Alberta. The route of this highway commences at Sinclair, on the Kootenay River Valley road north of Windermere, proceeds along Sinclair Creek to the Kootenay Valley; thence along the Vermilion River to the Vermilion Pass (elevation 4,662 feet) at the Alberta boundary. Of this road, about 23 miles was constructed between the years 1912 and 1914, leaving about 48 miles to complete. Early in 1919 the uncompleted section was taken over by the Dominion government, which entered into an agreement with the British Columbia government to complete the road before the expiration of four years. This projected highway is situated midst magnificent mountain and valley scenery, a large area of which is being reserved for park purposes, and will eventually afford access to the Banff National Park in Alberta.

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The following are the expenditures for the past four years:

	Roads	Bridges	Total
1915-1916	$1,634,678.00	$ 408,701.00	$2,043,379.00
1916-1917	1,407,499.00	496,964.00	1,904,463.00
1917-1918	1,026,770.00	238,452.00	1,265,222.00
1918-1919	996,540.00	430,500.00	*1,427,040.00
	$5,065,487.00	$1,574,617.00	$6,640,104.00
Annual average	$1,266,372.00	$ 393,654.00	$1,660,026.00

*Estimated.

SASKATCHEWAN

By H. S. Carpenter, Deputy Minister of Highways

In the year 1917 the board of highway commissioners, which previous to this date had been in charge of highway construction and maintenance work carried on by the government of the Province of Saskatchewan, was abolished and the department of highways was formed as a regular department of the Provincial government to carry on this work. Highway work in the Province is now carried on by this department of highways and also by the rural municipalities. About 80 per cent. of the settled area of the Province is now organized into rural municipalities and these have now become so well established and strengthened financially as to be able to undertake a very considerable part of the burden of highway construction and maintenance.

The duties of the department of highways are as follows. (1) To lay out, plan and determine upon a system of public highways for the Province, which system may from time to time be altered or modified as the minister may determine; (2) to determine upon the most feasible and economic methods for constructing, improving and maintaining public highways; (3) to furnish the officers of municipalities with information respecting the construction, improvement and maintenance of public highways; (4) to make such rules and regulations as may be deemed advisable respecting the duties and responsibilities of its officers, clerks and servants; (5) to determine the conditions of employment for foremen, sub-foremen, mechanics, workmen, day laborers and teams.

All roads in the Province are classified as: (1) Provincial highways, (2) interurban roads, (3) main market roads, (4) feeder roads.

The department of highways limits its expenditures to assisting

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rural municipalities on the improvement only of the first three classes of roads, leaving to the rural municipalities the improvement and maintenance of feeder roads.

Rural municipalities generally have not attempted the construction of the larger bridges, and practically all bridges of 20-foot span or over are constructed by the department and an exception is made in the case of bridges from the general policy in that the department undertakes the construction of bridges on some roads which are not included in the first three classifications. The use of the road drag is encouraged, and as a result of annual road drag competitions which have been conducted by the department for several years it is now being widely used for the improvement of earth and gravel roads. In 1918 over 3,000 miles of roads were kept in repair by the use of the drag. The department also constructs, maintains and operates all the ferries in the Province, which in 1918 numbered 44.

The appropriations made by the Provincial legislature for expenditure under the highways department in 1919 are as follows:

Chargeable to Income:	
Roads and bridges including aid to rural municipalities	$600,000.00
Ferry accommodation	115,000.00
Surveys	45,000.00
Drainage expenditure	50,000.00
Chargeable to Capital:	
Construction of public highways	335,000.00
Permanent steel or concrete bridges	220,000.00

While the war was on, the expenditures by the department were considerably curtailed, being limited only to such work as was immediately necessary to provide facilities for our farmers to market their grain crops. It is hoped that now that peace has come that considerably larger amounts will be placed at the disposal of the department for carrying on its work.

Outside the cities and towns no attempt has yet been made to construct roads with a paved surface. Material from which to obtain road material for the better class of pavements is at present unobtainable within the Province at prices which make it commercially possible to attempt construction of permanent pavements on our rural highways. At the present stage of development the energies of both the department and the rural municipalities are taken up mostly with the grading of those portions of the roads which are impassable because crossed by a coulee, slough or other obstacle and constructing bridges over our streams. The Province now has a very considerable mileage of well graded earth and gravel roads.

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ALBERTA

Compiled from Reports by L. C. Charlesworth, Deputy Minister of Public Works

The Provincial Highway Act of 1918, which came into force in January, 1919, provides for the division of the highways of Alberta into three classes:

(a) Main highways, designated as such by the minister of public works either by reason of being trunk lines connecting the more important cities and towns of the Province or with the main traveled roads situated outside and adjoining the Province or for other suitable reasons. The municipalities interested are selected and when the route has been decided the roads are designated main highways by Order-in-Council. The department of public works bears 75 per cent of the cost of construction and the entire cost of maintenance, the local authorities 25 per cent of the cost of construction.

(b) District highways, designated as such by the minister of public works and established by Order-in-Council, after agreement with the municipal authorities of the districts through which they are intended to run. These roads are of more than local importance, but not of sufficient importance to warrant their designation as main highways. The department of public works bears 25 per cent of the cost of construction, and the local authorities bear 75 per cent of the cost of construction and the entire cost of maintenance.

(3) Local highways, forming the residue of the roads in the Province to be constructed and maintained entirely at the expense of the local authorities within the districts in which they are situated.

The department of public works exercises control of construction in the case of main highways and may do the same or share such control with the local authorities in the case of district highways, according to the agreement undertaken. Where the local authority fails to maintain the district highway, the department may undertake this, recovering the cost from the local authority. This provision extends to bridges damaged by flood or accident when the cost of repair is voted by the legislature for the purpose. The local authorities are thereby relieved of the charge of repairing such bridges.

The minister of public works has power to make rules for the control of all traffic and vehicles, including regulations as to the width of tires for various roads.

At present Alberta has none but earth roads, careful maintenance of which will prepare the way for permanent road con-

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struction when the full provisions of the Act will be taken advantage of.

In 1916 the Province spent $758,261 on the improvement of highways. In 1919 the legislature voted for various highway purposes a total of $925,000. Municipal expenditure on roads has now passed the milion mark.

MANITOBA

By A. McGillivray, Highway Commissioner

Road improvements in Manitoba are being carried on under "The Good Roads Act, 1914." This act provides for government financial assistance to the municipalities on main market roads to the extent of one-third of the cost of earth roads and one-half of the cost of gravel or broken stone roads, and two-thirds of the cost of Provincial highways. The cost of all culverts and bridges is included as a part of the cost of the roads. Assistance is also given in the building of bridges constructed on roads which do not form part of a system under the act. On a permanent structure costing $200 or over, one half the cost is given and on a wooden structure costing $500 or over, one-third.

Organization.—"The Good Roads Act" is administered by the good roads board under the department of public works of the Province. This board consists of three members, of which the highway commissioner is chairman. Attached to the board are a chief engineer and engineers, surveyors, draughtsman, inspectors, clerks, etc., as are necessary to carry on the work being performed. The engineering staff is divided into two branches, one to take care of the bridge work and the other the road work. For the purpose of better handling the work and of keeping in closer touch with it the Province at the present time is divided into 4 bridge districts and 8 road districts, with an engineer assigned to each of the districts. The bridge engineers work from the central office in Winnipeg, while the road engineer takes up his residence in his district, making a central point his headquarters.

A district engineer has charge of all road work and a general supervision of bridge work in his district. Where such assistance is required, the district engineer has one or more assistants. At the present time there are 9 such assistant engineers, 3 of whom are on the permanent staff and 6 as yet but temporary employes. Where a scheme of work is being carried out in a municipality of such magnitude as to warrant it, the municipality is required to engage the services of a resident engineer on the work. The expenses and salary of this engineer are charged against the cost

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of this showing must reveal the fact that the good roads have been materially responsible for the education of 10 children out of each 100. As the struggle for existence becomes keener in the years that are yet before us, the educational training which the children receive in the country schools will make itself felt more and more in the material and moral success of the man and woman. Not only have the roads contributed toward a larger school attendance, but they have been quite instrumental in lifting the standard of instruction by making easier the consolidation of little one-room schools into graded schools. In Dinwiddie County, Virginia, the system of taking the children to and from school by means of wagons has been adopted since the roads were improved."

Improvement of Rural Delivery Service

The beneficial effects of the rural free delivery service upon the happiness and home comforts of our rural population have become established facts, and nothing contributes so much to its efficiency and regularity as good roads. The Fourth Assistant Postmaster General, Hon. James I. Blakslee, is authority for the statement: "Essential factors in the value of rural delivery as a postal facility are speed and regularity and the attainment of a satisfactory standard in these particulars is absolutely dependent on improved roads."

The total mileage of rural routes in operation on December 1, 1919, was 1,147,609 miles. The daily travel by carriers was 1,131,633 miles, which is nearly one-half the total road mileage of the country. There were on the same date 43,342 delivery routes having a minimum length of 7 miles, a maximum of 36 miles for horse-drawn vehicles, and of 70 miles for motor vehicles, and an average length for all routes of 26.48 miles each. The cost per mile traveled by the carriers could be greatly reduced and the length of many of the routes could be increased by the use of motor vehicles if the roads were generally improved.

In many instances the Post Office Department has found it necessary to discontinue rural routes because of the impassable condition of roads. In fact there were 205 more rural delivery routes on February 1, 1917, than on December 1, 1919.

In addition to the rural delivery and star service, the Post Office Department has also established several motor vehicle and county motor express routes.

A recent statement issued by Mr. Blakslee indicates that on November 30, 1919, there were in operation 5 motor vehicle truck routes covering a distance of 903.8 miles daily at an estimated cost of $67,500 per annum and 4 county motor express

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routes covering a distance of 971.2 miles daily at an estimated cost per annum of $55,000.

Mr. Blakslee further states that during the period from July 1 to September 30, 1919, trucks operated on the motor vehicle truck routes covered a total distance of 63,704 miles and carried a total of 353 tons of mail matter or more than 1½ tons per day per route, and that the trucks operated on the motor express routes covered a total distance of 24,883 miles and carried a total of 90 tons of mail matter or 1¼ tons per day per route. Mr. Blakslee states that the value of this service is not confined altogether to postal revenues, but it is of special benefit to postal patrons in that foodstuffs transported over the routes are delivered at a cost considerably below the prevailing minimum market price at which the patron would have purchased the same article had the service not been available.

A statistical statement furnished by Mr. Blakslee indicates that on 58 trips made by this service between August and November, a total of $6,612 was saved to consumers by the use of this service.

It is evident that the motor-truck service, like that of the rural delivery, is limited in its effective operation on account of the condition of the roads. While this service is still in the experimental stage, the results thus far indicate that it will be gradually extended to all parts of the country as soon as the roads are so improved as to permit of the general use of motor vehicles throughout the year.

Improvement of Social Conditions

The social conditions of rural communities are matters of serious consideration. If the term "social condition" is analyzed, it will be found that all social activity is dependent upon the gathering of people for some common purpose. It is not difficult, therefore, to see the connection between desirable social conditions and the improvement of public roads. Social institutions, such as schools, churches, and public amusements are more or less subject to valuation in any community, but they are by no means the complete measure of social conditions in that community. Those subtle and delicately adjusted relations which obtain in any neighborhood are equally dependent in the community upon road conditions. It is necessary to mention these intangible things if one is to have the breadth of view to understand the influences which make for the final status of country life.

The aesthetic value of roads well built and clean is sometimes

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reluctantly conceded or even denied by individuals. It is noticeable, however, that along improved roads there is a visible tendency for farmers to improve the appearance of their homes and their outbuildings. In fact the presence of good roads seems, oftentimes, to stimulate latent self-respect into practical expression. There is no wonder that a bog of well-nigh impassable mud before one's door should react unfavorably upon the entire family. The improved road not only has an aesthetic value in itself, but is potent in awaking the dwellers along its borders to a sense of aesthetic values in farm buildings and home surroundings.

Social activities in rural communities need all the encouragement and stimulus that can reasonably be given. All social activities take time and energy, and the country-road condition, therefore, is a prime consideration to enable farmers and their families to afford time for social intercourse. The unnecessary subdivision of the church into numerous small buildings throughout many portions of the country has necessarily operated to weaken the attendance, but the concentration of church funds and church attendance is dependent upon improved road conditions.



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GOOD ROADS

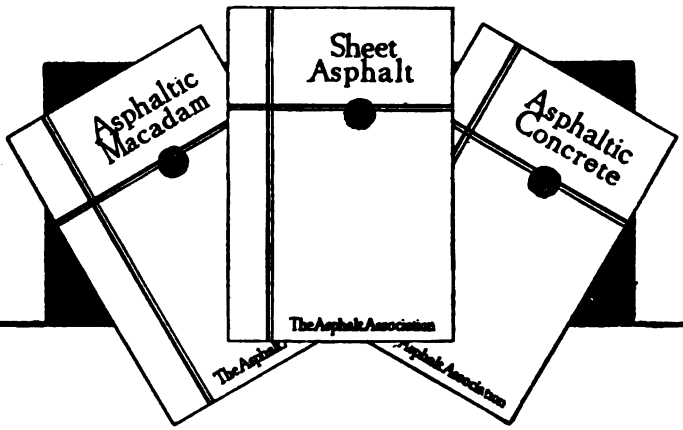
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PART II

Construction and Maintenance of Rural Roads

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DRAINAGE OF ROADS

By T. R. Agg, Professor of Highway Engineering, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa

The importance of drainage for all roads subject to the effects of storm or underground water has always been recognized to some extent by road builders, but during recent years constantly increasing attention has been given to this phase of road construction. It is unfortunate that there has been some tendency to consider drainage of less importance where rigid types of surfaces were being constructed than where some of the less stable surfaces were employed. It is apparent, from the nature of the defects observed in all sorts of road surfaces, that to neglect or minimize the importance of drainage in connection with either earth roads or any class of surfaced roads is to invite rapid deterioration of some sections of the roadway surface and to add to maintenance costs.

The degree to which drainage effects the serviceability of the road surface is a variable factor depending upon the amount of precipitation in the locality and the manner in which it is distributed throughout the year. In the humid areas of the United States, which are, roughly, those portions east of a north and south line passing through Omaha and Kansas City, and the northern part of the Pacific slope, precipitation is generally in excess of 30 inches per year and distributed throughout the year, but with seasonal variations in rate. In these areas, the effect of the precipitation, both as regards its tendency to lower the stability of soils and as an eroding agent, is to be considered.

Outside of these areas the precipitation is much less and its effect as an agent of erosion is of greatest importance, although in restricted areas there may be short periods when the soil is made unstable by ground water.

The drainage system for a proposed road improvement ought to be designed with as much care as any other element, and to do so, a study must be made of all factors, such as the nature of the soil, amount and distribution of rain and snowfall and the local topography, that have any bearing on the drainage requirements and the probable effectiveness of the proposed drainage system. The well established principles of land drainage should be followed so far as applicable.

The basic principle of road drainage is to minimize the effect of water to such an extent that there will always be a layer of comparatively dry soil of appreciable thickness under the travelled

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part of the road. This layer should probably never be less than two feet thick and for soils of a structure favorable to capillary action it should be at least three feet thick. The means employed to accomplish the requisite drainage will be as various as the conditions encountered.

Surface Drainage

The drainage method which is by far the most nearly general in application is that which utilizes open ditches, and the system which employs these ditches in usually referred to as surface drainage. The full possibilities of this method of minimizing the effects of storm water are rarely fully utilized in road construction. Very frequently, deterioration of a road surface is directly attributable to failure to provide adequately for the removal of the storm water or water from snow that has fallen on the road, or water that flows to the road from land adjacent thereto. Surface water can usually most cheaply and expeditiously be carried away in open ditches, although special conditions are occasionally encountered which require supplementary tile drains. The cross section commonly adopted for roads lends itself naturally to the construction of drainage ditches at the sides of the travelled way, and these are usually the principal dependence for the disposition of storm water.

Run-off.—The capacity and slope of side ditches required to insure adequate surface drainage will be affected by the amount and nature of the precipitation in the region where the road is built. The annual rainfall in a region may amount to several feet, but may be well distributed throughout the year with an absence of excessive rainfall for short periods, that is, flood conditions may rarely occur. In other areas, the annual rainfall may be comparatively small and the precipitation occur at a very high rate, or it may be at a low rate extending over a considerable period. These peculiarities must be known before an adequate drainage system can be planned.

It is almost universally true in the United States that precipitation at a high rate will be for a relatively short duration, and during these short periods, which usually do not exceed thirty minutes, a portion of the water that falls on the areas adjacent to the road and that drains to the road ditches will soak into the soil and therefore not reach the ditches along the road. The extent to which the water is taken up by the soil will vary with the porosity of the soil and the character of the growth thereon. Cultivated land will absorb nearly all of the water from showers up to fifteen or twenty minutes duration; grass land a somewhat smaller percentage; and hard baked or other impervious soil will

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absorb a comparatively small amount. Rocky ground and steep slopes will absorb very little storm water.

The surface of the road is designed to turn water rapidly to the ditches, but when the material is the natural soil, there is always considerable absorption of storm water. Surfaces such as sand-clay, gravel and macadam do not absorb to exceed 10 per cent of the precipitation during short showers. Bituminous surfaces, brick and concrete pavements do not absorb an appreciable amount of storm water.

Generally it is best to assume that if a rain lasts for forty-five minutes or more, all of the water will run off, as the soil will reach a state of saturation in that time. This is not true of deep sand, but is for nearly all other soils.

The ditch capacity needed will therefore depend upon the area drained, the character of the soil, the slopes and the rainfall characteristics of the region, and upon the nature of the road surface.

For a required capacity, the cross section area of the ditch will vary inversely as the grade, because the velocity of flow increases with an increase in the grade of the ditch. If the surface water must be carried along the road for distances exceeding five or six hundred feet, the ditch must be constructed of increasing capacity toward the outlet in order to accommodate the accumulated volume of water.

The velocity of flow varies not only with the grade, but with the shape of the cross section, cleanness of the channel, the depth of water in the channel, alignment of the channel and the kind of material in which the channel is formed. It is not necessary to go to great refinement in the design of the side ditches for the ordniary case where the water is carried along the road for only a few hundred feet. The ditches are made of ample capacity by using the commonly accepted cross section for a road, which will be discussed in a later paragraph. But where large areas must be drained by the road ditches, it is desirable to design carefully the side ditches. The basis for that design is too lengthy to be included herein.

Ordinary Design of Ditches.—For grades of 1 per cent or less, the bottom of the ditch should be at least 3½ feet lower than travelled surface of the road. For grades greater than 1 per cent, this depth may be decreased one foot, and for grades of 4 per cent and upward, the depth may be still less. These general rules for depth are susceptible of variation but are believed to be the minimum except in arid or semi-arid climates. It is far better to be too liberal in ditch allowance than to be too conservative. In arid or semi-arid regions, the ditch design will be based on the necessity of providing for flood flow and pre-

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venting damage for erosion. Ordinary drainage requirements will be satisfactory with the ditch about one foot deep.

If the topography adjacent to the road is such that it is evident considerable storm water will flow from the adjacent land to the road ditches, the design must be modified to take this into account. Sometimes such water can be diverted by ditches well back from the road, and thus prevented from flowing into the side ditches along the roadway. It is especially desirable to divert water, which would otherwise flow down the slope of a cut, by means of a ditch on the hill-side above the upper edge of the slope of the cut.

Ditches are not effective unless they afford a free flow throughout their length and have an outlet to an adequate drainage channel of ample capacity. Therefore, ditch grades should be established by survey, especially if the gradient is less than 1 per cent, and the construction work should be checked to insure that the ditch is actually constructed as planned. A few high places in the ditch will greatly reduce the effectiveness, although these may appear at the time of construction to be slight. Constricted places, such as might be due to a small amount of loose earth left in the ditch, are always to be avoided.

Where the side ditch passes from a cut to the berm alongside a fill, the ditch should be excavated throughout in the undisturbed natural soil, 5 feet or more from the toe of the slope of the fill, and along the filled portion of the road there should be a berm of 3 or 4 feet between the toe of the slope of the fill and the near edge of the ditch.

Underground Water

In a preceeding paragraph, mention was made of the fact that only a part of the storm water runs off over the surface of the ground, the larger part being absorbed by the soil. The water thus absorbed flows downward through the pores in the soil until it is deflected laterally by some physical characteristic of the soil structure. The movement of underground water is effected by many circumstances, but only two conditions need be discussed herein.

Underground water, like surface water, tends to attain a level surface, but in so doing it may need to flow long distances through the pores of the soil, and to overcome the resistance incident to so doing some head will be required. That is to say, the water will be higher at some places than at others. If a cut is made in grading the road, the road surface may actually be lower than the ground water level in the land adjoining the road. As a

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result, the water will seep out of the side slopes in the cut and keep the ditches wet, or even furnish enough water to occasion a flow in the ditch. Similarly, the higher head of the underground water near the top of a hill may result in groundwater coming quite close to the surface some distance down the hill. The remedy in both cases is tile underdrains alongside the road to lower the groundwater level so that it cannot effect the road surface.

Sometimes the groundwater encounters an impervious stratum as it flows downward through the soil, or one that is less pervious than the surface soil. When such is the case, the water will follow along this stratum, and should there be an outcrop of the dense stratum, a spring will be found at that point. This may be on a highway. Or the impervious stratum may not outcrop but may lie only a few feet under the surface of the road, in which case, the road surface will be so water soaked as to be unstable. This condition can be corrected by tile laid so as to intercept the flow at a depth that precludes damage to the road. Commonly, the tile will be laid diagonally across the road some distance above the section where the effect of the water was noted, and will be turned parallel to the road and carried under one of the side ditches to an outlet.

Tile Drains.—Where the soil and climatic conditions are such that the roadway at times becomes unstable because of underground water rising to a level not far below the road surafce, the groundwater level is lowered by means of tile underdrains. The function of the tile drains in such cases is precisely the same as when employed in land drainage to lower the groundwater level.

The tile lines are usually laid in trenches parallel to the center line of the road near the ditch line and at least 4 feet deep so as to keep the groundwater level well down. They must be carefully laid to line and grade. A good outlet must be provided and the last few joints of pipe should be bell-and-spigot sewer pipe with the joints filled with cement mortar. The opening of the tile should be covered with a coarse screen to prevent animals from nesting in the tile.

It is frequently necessary to lay a line of tile at the toe of the slope in cuts to intercept water that will percolate under the road from he banks at the sides. In some cases, it is desirable to backfill the tile trench with gravel or broken stone to insure rapid penetration of surface water to the tile. In other instances, it is advantageous to place catch basins about every three or four hundred feet. These may be of concrete or of tile placed on

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end or may be blind catch basins formed by filling a section of the trench with broken stone. When a blind catch basin is used, the top should be built up into a mound, and for a tile or concrete catch basin, grating of the bee hive type should be used, so that flow to the tile will not be obstructed by weeds and other trash that is carried to the catch basin.

Road Foundations

The transition from horse drawn to motor traffic has come about so quickly that it has been impossible to revise construction methods and design rapidly enough to keep pace with traffic requirements. Formerly, the emphasis was placed on the construction of a smooth and durable wearing surface. The loads were not such as to require minute attention to the foundation, and the wearing surface was constructed as a crust which was usually strong enough to bridge over weak places in the foundation. Now, the engineer must not only provide a wearing surface of sufficient durability and smoothness to be satisfactory for high speed traffic, but must also provide a foundation of sufficient rigidity to carry loads about five times as heavy as those formerly provided for.

Thorough drainage of the supporting earth is the first step in the preparation of the foundation.

The second step is to design a foundation of sufficient stability to carry the loads. With such types of surface as Portland cement concrete and monolithic brick, the foundation and wearing surface are integral. The foundation for roads with a bituminous wearing course may be of Telford, ordinary borken stone or of Portland cement concrete, but the requirements on all main roads are becoming so rigid that Portland cement concrete is likely to prove most economical.

It is certain that to try to economize in the construction of the foundation course is to invite disaster, and the trend is decidedly toward heavier and better constructed foundations. The exact type and design will logically vary with the thoroughness of the drainage and the character of the soil upon which the road is constructed.



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MOUNTAIN HIGHWAY RECONNAISSANCE

By T. A. BEDFORD, *Division Engineer,*
California Highway Commission

The selection of highway routes in a mountainous region requires the exercise of certain well developed faculties almost as rare as what is sometimes called "horse sense."

The reconnaissance engineer must have a keen sense of proportion, of course and distance, and of locality; something almost akin to animal instinct. If he does not possess this he had better specialize on something else.

Any competent engineer may, by mechanical means, take accurate topography over all possible routes between two points and by trial lines, shifting and calculating, find in the course of time the most economical location for a highway and yet, in the end, get it in the wrong place and have no money left to build with.

As for methods, the first things to be determined are the points which are to be connected by the road; next, a thorough knowledge of the topography of the intervening country should be gotten by walking out the ridges and climbing the highest peaks to get a general idea of the topography, and then following the canyons or main water courses to get a more accurate knowledge of the topography, as the road will most likely follow the water courses.

Thus with a mental picture of thousands of square miles of topography standing out before the mind, like a huge relief map, roads must be "looked into" place and the likely routes selected for further examination. The controlling points and influence points on the routes should be picked out next and probable selection made and a determination made if a grade line run from one to the other will fall below the maximum grade adopted. These grade lines should be developed by well-trained assistants who may work singly in open country, but who must work in pairs in dense undergrowth. With clinometers and flags trial grade lines are run between controlling points and bits of colored cloth tied on the branches as markers.

After the final route is selected, it is gone over carefully and strips of white cloth are tied on branches of trees to guide the chief of survey party, who runs a preliminary line from flag to flag. If the reconnaissance work is well done the final location will fall within the cross sections taken from the preliminary line.

In a large per cent of mountain road problems snow conditions

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materially influence the location of the road. A road located with a southern exposure and exposed to the sun's rays and the warm south winds, will be clear of snow much longer than a road with a northern exposure. Furthermore, since the snow lies longer on the northern slope and the sun does not reach it to dry it out, the vegetation is heavier and the soil is much deeper and the roadbed harder to drain and slower to dry out.

A hillside location may be preferable to a location through an adobe flat carrying an excess of irrigation water. A higway mountain ridge route, open and cool, with plenty of desirable camp sites, though closed a portion of the year by snow, may be preferable to a deep canyon route, which is open the year around, if the principal traffic is to consist of summer tourists and the canyon be narrow and hot with few places to turn off the road. But if the principal traffic is to be freight traffic, which will be continuous through the winter, then the canyon route is to be preferred. Such considerations, however, may lead the engineer into prophecy. Who can say what the future may bring, or what class of traffic should be favored?

The writer believes that the location of highways is an art rather than a science. An engineer with "a good eye for country" and for the beautiful, and equipped with plenty of experience and "horse sense" almost seems to know where a road should go, oftentimes without the need to consider why.

The essential requirements for a good mountain road are good drainage, easy grades, and as good alignment as the topography of the country and the funds available will permit. These same factors also control the width of roadway which may be secured. If possible this should not be less than 16 feet of traveled way, and this width should be increased on sharp curves.

Proper super-elevation on sharp curves makes for safety to traffic and reduces maintenance. This super-elevation in inches per foot width of roadway should equal ½ plus 75 divided by the radius of curvature. $(\frac{1}{2}+75/R.)$

Grades should be compensated on curves on highways as well as on railroads. A maximum grade of 6 per cent on tangents, which should be secured if practicable, should be reduced by 75 divided by the radius of curvature. In other words, the grade on a 50-foot radius curve, which should be the minimum radius used, should be reduced from 6 per cent to 4½ per cent.

These recommendations are for motor roads rather than for roads for horse-drawn vehicles.

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EARTH AND SAND-CLAY ROADS[1]

As a very large proportion of our country roads must be earth roads for many years and the basis for any type of surfaced highway is a properly located, drained and graded earth road, the relative importance of this type is very great. If earth roads were properly constructed and maintained, and their culverts and bridges were permanent structures, a large part of the road taxes now wasted would produce useful returns. It is proper for both highway commissions and engineers to devote a large part of their time and money to the improvement of the main roads which are of service to the largest number of taxpayers, but there is a deplorable lack of efficiency in the care of the local dirt roads in many parts of the country.

The construction of earth roads falls into two general classes, that where there are cuts and fills and that where the road is formed by building a low embankment on the surface. Except where the length of road is great enough to use elevating graders with economy, these two classes are generally built by different methods.

Cuts and Fills

In grubbing roots and breaking hard ground to a shallow depth, a rooter plow is often used, which is a heavy type of subsoil plow made for the purpose. The road plow is a heavy form of turning plow used in hard ground where the cuts are shallow. Either type is drawn by four to eight horses or a tractor. Plows are also specially made for pushing soil already loosened from ditches toward the center of the road.

When the cut is more than a few feet in depth and the material loosened with difficulty, it is often blasted. The fastest and most economical method of doing this is to sink holes across the cut on a line back from the face a distance about one-fourth greater than the depth of the cut and about the same distance apart. When the cut is 6 feet or more deep, the line of holes is kept about 6 feet from the face and the holes are sunk about 6 feet apart. They are loaded with a low-strength explosive and care must be taken not to loosen the ground below the finished grade line. The blasts leave the clay or hardpan in a broken-up condition, making it easy to handle. On side-hill cuts in heavy ground, where the slope is steep and there is some question about the security of an embankment to carry the outer part of the road, a safe roadway can often be blasted out of the hill at a cost

[1] Revised by W. S. Keller, State Highway Engineer of Alabama.

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comparing favorably with a road partly supported by a retaining wall. Even on easier slopes, where a long side-hill cut in heavy ground must be made and the excavated material can be employed as an embankment to carry the outer part of the roadway, the excavation is often made by blasting. Blasting is also an effective method of breaking up stumps and boulders.

Where the material is easily handled and can be dumped within 100 feet of the cut, slip scrapers are generally regarded as the least expensive equipment. The Fresno scraper is regarded as better than the slip scraper for hauls exceeding 100 feet. If the haul exceeds 100 feet and is under 1,000 feet, wheel scrapers are ranked highly. The large sizes are most desirable for economy on hauls over 600 feet. The material is usually plowed so the wheelers can be loaded easily, and it is necessary to have about one of them for every 100 feet of haul in order to work most economically. Bottom-dump wagons can be made to give very low hauling costs if enough are provided so that while one is being loaded at the cut, the driver and team which brought it in can be used in hauling a loaded wagon.

In recent years traction steam shovels have been growing steadily in favor for road grading. They make shallow cuts as easily as deep cuts, and have taken out earth and rock at very low figures when the equipment for removing the excavated material was properly selected and used so as to keep the shovel working most of the time. The economy of steam-shovel operation depends upon the proportion of the working day that it is actually digging, and this depends upon having wagons or cars ready to receive the excavated material. The wagons or cars may often be run along the top of the bank of a shallow cut and kept moving in a continuous line, saving the delay of turning and backing up to the shovel, which is necessary when they move over the graded cut. The utility of a shovel on road-work is increased if it can be employed in a gravel pit or quarry when not grading.

The bottom of the cut should be carried down approximately parallel to the finished cross-section, and care should be taken not to disturb the material below the grade line. In very heavy ground, the final trimming is sometimes done by hand, but generally a road machine can be used to advantage.

Where a fill is made, the surface must be cleared. Stumps should be grubbed out[1] and all large material liable to decay

[1] It is not customary in the South to require green stumps and roots to be grubbed where the fill over their tops is as much as 18 inches. Any matter in process of decay must be removed but a green stump sealed in a fill so that air will not reach it lasts forever.

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should be removed, for if left in place the fill will settle as it rots or have loose places likely to retain moisture. If the fill is on a steep side-hill, the latter should be cut into a series of level benches or steps and the drainage should receive careful attention. If the hill has a gentle slope, it is usually sufficient to plow parallel furrows, which will furnish a sufficiently uneven surface to hold the fill. The object in any case is to unite the material in the bottom of the embankment with that of the hillside.

If the road will be maintained as an earth road for several years, so it will have ample time to become consolidated under traffic before any surfacing is applied, there is usually little reason for limiting the thickness of the layers in which the embankment is built. But if a surfacing is to be given the road at an early date, the layers should not exceed 2 feet for high fills and 1 foot for low fills. The teams and scrapers moving over the fill compact it to some extent. Formerly little attention was paid to smoothing the surface of the layers, but of late this has been considered important in some states and drags are kept at work on a bank a large part of the time.

All embankments settle or "shrink" for some time after they have been built. If the material is broken into small pieces and trampled by teams, the shrinkage will be less than if it is dumped in large masses. There is little shrinkage in a well-built earth dam to impound water, but road embankments need not be built so carefully, and it is probably desirable to allow for at least 10 per cent shrinkage of embankments over 3 feet high and at least 15 per cent for those under 3 feet. If loamy material is used in the embankments the shrinkage will probably be greater than this.

Grader Work

A large part of the earth roads now built or reconstructed are made with road machines. These are built in many sizes for both horse and tractor hauling, and serve a variety of purposes in an economical manner. They are not adapted for making cuts and fills, although frequently employed in shaping a road after the grading has been done. The method of using the machine on construction is explained in the following instructions prepared by W. S. Gearhart, of Kansas:

In building new roads with a road grader the dead weeds and grass should first be burned off before any grading work is done, and the width of the road to be graded should be staked so the ditches can be properly lined up. Then plow a light furrow with the point of the grader blade, carrying the rear end of the blade well elevated.[1] On the second round

[1]A plow is necessary in breaking up the ground except in light soils.

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drive the wheels in line with the point along the hollow made the first round, plowing a full furrow with the advance end of the blade, dropping the rear end somewhat lower than before. The third time move toward the middle of the road the earth previously plowed, then return to the ditch and plow it out deeper, moving the earth toward the middle whenever as much has been plowed as the machine will move at once. Repeat this process until the ditches are the proper depth, and then cut off the outer slopes of the ditches by placing one wheel of the grader in the bottom of the ditch and the other one on the bank. This can be done easily if the bank is not more than 30 inches above the bottom of the ditch. Then trim the earth to the true cross-section. Thoroughly harrow the loose material with an ordinary straight-tooth harrow if there are no clods, going over it until the bumps have been leveled off, the low places filled up and the material well compacted. If there are sods or tough lumps of earth in the road a disk harrow should be used to pulverize this material, and the disk harrow should be followed by a drag or a straight-tooth harrow to level and smooth the road. No newly graded road can be finished in good shape without using either the harrow or the drag, or both.

In the later rounds of a road machine, in the final shaping of the road, part of the loose material in the center of the road is pushed back to the shoulders. The settlement on fills will result in losing about 2 feet in the width of the roadway, and the fills should be made wider than the standard sections to allow for this loss. In doing this final work, the blade of the grader is set at an angle of about 45 degrees with the direction of travel, its ends adjusted to the slope of the road, and lowered as a whole on successive rounds.

If the work is on a scale large enough to warrant the use of two graders hauled by a tractor or roller, a trained grading crew is often able to build a good roadbed at very low cost. Mechanical traction has resulted in the development of methods of construction impracticable when teams of four to eight horses were employed, and as a general proposition mechanical traction is most economical when the sections to be graded are a quarter of a mile or more long, and there is enough work in the vicinity to keep a tractor busy most of the time. Time lost in standing idle or moving long distances from one grading job to another reduces the economical advantage of a tractor on work not well organized. In many cases the hauling is done by a road roller. Tractors and rollers are particularly good investments where labor and teams are hired at high rates and not always obtainable. Mechanical traction is so much more powerful and rapid than horse traction, that its total saving on road work can only be figured by including the saving in labor charges due to speedy construction.

Where road grading is carried on by day labor by district officials, preparation is sometimes made for it in late fall or early

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spring by plowing up the ground along the lines of the ditches and slopes. This disintegrates the sod and prevents the roots of grass and weeds from forming clods which must be broken up by disk harrows or thrown out of the road with forks. While it is allowable to build an embankment on good sod after it has been burned over, neither sod nor any other organic material should be allowed in the embankment unless reduced to small, disconnected bits. If clods are left in a fill, particularly in the top, it is very difficult to maintain by dragging a hard, uniform surface free from depressions and waves.

In organizing grader work, it is desirable to keep on hand repair parts of the machines, such as blades and whiffletrees, as well as plow points and other parts of the equipment likely to wear out. The small tools should be selected with care, for observation by efficiency specialists has shown that the shape of a shovel, for example, has considerable effect on the amount of shoveling a man can accomplish in a day. Hard earth cannot be dug economically by the shovel best adapted for loose earth, and neither is best for gravel and broken stone.

On extensive work the elevating grader has proved an economical and rapid machine when a mile or more of road can be traversed without turning the outfit. Such a grader is often hauled by a traction engine, which rolls the material it passes over and thus assists materially in making a compact road. The method of using the grader depends upon the nature of the work to be done. In cuts, the grader often discharges the excavated material into wagons driven beside it until full. These wagons haul the material to the nearest fills. In light cuts, the material is deposited on the roadway and moved to the nearest low places in the road by slip or wheel scrapers. The cut is usually started at the shoulder and the grader moves toward the roadside on successive rounds, so that the excavated material is deposited nearer and nearer to the center of the road by the elevating and discharging device. The road should be dragged during construction, and as soon as the rough grading is finished it should be shaped at once. In this connection attention is called to the following comment by the Iowa highway commission:

> The impassable condition to which some contractors and county road crews reduce their roads while cuts, fills and other improvements are being carried out, is absolutely inexcusable. The worst conditions usually arise at leveling or smoothing up while dumping is in progress. The dirt of the fill so dumped packs in humps so that sometimes it is impracticable to eradicate the unevenness for years. A little care in spreading the dirt evenly at the time of dumping results in the fill packing in thin, even layers instead of humps. Such a road is travelable during construction, and when the fill is completed the job is done. A Marshall County road

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crew solved the problem by keeping a light road drag at hand. From time to time a team was unhooked from a scraper and hitched to this. A few minutes work put the freshly dumped material into thin layers instead of humps.

Dragging

Earth roads under light traffic can be kept in good condition during a large part of the year by dragging and proper care of the ditches. It is an axiom in road maintenance that defects in the surface of a road should be remedied as soon as they appear, because traffic will develop them quickly. The earth road is particularly subject to injury because it does not have hard stone locked in place to resist the destructive effect of horses' shoes, narrow tires and pneumatic tires. On the other hand it is more easily repaired than any other road, because as soon as its surface is wet by rain the ruts and holes can be filled by hauling a drag over the surface. This scrapes material from the high points into the depressions and rubs down the whole surface. The following explanation of the nature of the improvement has been given by A. R. Hirst, State highway engineer of Wisconsin:

If a sample of moist earth is taken from the traveled portion of a road over a gumbo, clay or black prairie soil, it will be found practically impervious to water, as may be proved by forming a roughly shaped dish of damp earth and filling it with water. It will be noticed that the dish is practically water-tight. Earth in this condition is what the clay workers call puddled. It has been worked and reworked by the carriage wheels and animals' hoofs until nearly all the traveled portion of a sticky muddy road is covered with a layer of this impervious, puddled earth. As usually found on most of the roads, this puddled earth is full of holes and ruts, which are filled with water that cannot escape through the impervious soil. As long as the water remains the soil cannot dry out and the road is kept in a most uncomfortable if not impassable condition. It is also a matter of observation that this puddled earth when compressed and dried becomes extremely hard. On these two facts, the imperviousness of puddled earth and its hardness when dried, rests the theory of road dragging.

When the road drag is properly used it spreads out the layer of impervious soil over the surface of the road, filling up the ruts and hollows until a smooth surface is secured. As a small amount of material is always to be pushed to the center, a slightly rounded effect will be given to the road, which may be increased or decreased as desired by subsequent dragging. By forcing the mud into the hollows and ruts it is evident that the water must go out, which it does by running off to the side of the road. The drying out of the road is thus much facilitated and the road is made immediately firmer because the water is squeezed out. The effect of traffic over the road tends to press down and thoroughly compact each thin layer of puddled earth which the drag spreads over the surface every time it is used. After the first few draggings it will be noticed that the road is becoming constantly smoother and harder so that the effect of a rain is scarcely noticeable, the water running off the surface which is so smooth and hard as to absorb but little of it.

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The drag is an old implement. It was described in a book by William Gillespie published in 1851 and widely used by students of engineering and public officials, yet the drag did not come into favor until about 1900. Even today it is not used on more than a small percentage of the roads where it should be employed regularly. It has a number of forms, the essential feature being two parallel blades held vertically or nearly so about 2½ feet apart by a frame of some sort. The bottom of each blade scrapes over the surface of the road. The rear blade projects 12 to 16 inches to one side of the front blade, so that when the drag is pulled at an angle of 30 degrees the ends of the blades will be on a line parallel with the center of the road. The drag is hauled by a chain, to which the team can be hitched at points that will make the drag lie diagonally on the road as it is pulled along. The manner of its use has been described substantially as follows by the United States Bureau of Public Roads:

Under ordinary circumstances the position of the hitching link on the draw chain should be such that the runners will make an angle of from 60 degrees to 75 degrees with the center line of the road, or in other words, a skew angle of from 15 degrees to 30 degrees. It is apparent that by shifting the position of the hitching link the angle of skew may be increased or diminished as the conditions require. When dragging immediately over ruts or down the center of the road after the sides have been dragged, it is usually preferable to have the hitching link at the center of the chain and to run the drag without skew. When the principal purpose of the dragging is to increase the crown of the road, the drag should be sufficiently skewed to discharge all material as rapidly as it is collected on the runners. On the other hand, if depressions occur in the road surface, the skew may perhaps be advantageously reduced to a minimum, thus enabling the operator to deposit the material which collects in front of the runners at such points as he desires by lifting or otherwise manipulating the drag. It is impracticable to prescribe even an approximate rule for fixing the length of hitch, because it is materially affected by the height of the team and the arrangement of the harness, as well as by the condition of the road surface. Experience will soon teach the operator, however, when to shorten the hitch in order to lessen the amount of cutting done by the front runner and when to lengthen it in order to produce the opposite effect. Care should be taken that a ridge, often called a "potato ridge," is not left in the center of the road.

When the road surface is sufficiently hard or the amount of material which it is desired to have the drag move is sufficient to warrant the operator standing upon the drag while it is in operation, he can greatly facilitate its work by shifting his weight at proper times. For example, if it is desired to have the drag discharge more rapidly, the operator should move toward the discharge end of the runners. This will cause the ditch end of the runners to swing forward and thus increase the skew angle of the drag. The operator may, of course, produce the opposite effect by moving his weight in the opposite direction. In the same way, he can partially control the amount of cutting which the drag does by shifting his weight backward or forward, as the case may be.

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The rule frequently cited, that all earth roads should be dragged immediately after every rain, is in many cases entirely impracticable and is also very misleading because of the conditions which it fails to contemplate. It is true that there are many road surfaces composed of earth or earthy material which do not become very muddy under traffic, even during long rainy seasons, and since such surfaces usually tend to harden very rapidly as soon as the weather clears up, it may be desirable to drag roads of this kind immediately after a rain. Such roads, however, would not ordinarily need to be dragged after every rain, because of the strong tendency that they naturally possess of holding their shape. On the other hand, many varieties of clay and soil tend to become very muddy under only light traffic after very moderate rains, and it is evident that roads constructed of such materials could not always be successfully dragged immediately after a rain. Sometimes, in fact, it may be necessary to wait until several consecutive clear days have elapsed after a long rainy spell before the road is sufficiently dried out to keep ruts from forming almost as rapidly as they can be filled by dragging. In many cases of this kind, however, it is possible greatly to improve the power of the road to resist the destructive action of traffic during rainy seasons by repeatedly dragging it at the proper time.

In the semi-arid regions, the soil is often of a very light nature, so lacking in adhesive qualities that strong winds or flowing water erodes it and travel abrades it rapidly into fine dust. It is in its best condition to carry travel when it is moist, but if it becomes saturated with water it is almost impassable. Chuck holes a foot deep are formed in dry weather in an earth road through such soil, and as they become filled with light dust they are a serious impediment to easy travel. Clay or gravel containing clay improves the roads when worked into them. The ditches should be wide and shallow, rather than deep, and the crown should be rather low for an earth road, in order to retain moisture in the roadbed. For the same reason, all grading and ditching are best done just before or during the rainy season, in order to have plenty of water to pack the soil. On account of the pulverulent nature of the material, the ends of all culverts must be planned carefully and riprap or some other material placed to prevent erosion about the inlets and outlets. The main problem with earth roads in such soils is to keep the roadbed damp and to incorporate with it adhesive or fibrous material which will act as a binder.

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Sand-Clay Roads

The grains of which sand is composed are usually hard and tough and able to resist abrasion if held securely in place. In an asphalt pavement they are held by the asphalt and a wearing surface of great resistance to abrasion results. In a sand-clay road they are bound together by clay in a less firm manner but one giving excellent results on well-drained roads carrying light traffic. The aim of the builder of such a road is to employ just enough of the stickiest clay at his command to fill the pores of the sand and to mix these materials together so thoroughly that there are neither lumps of clay nor pockets of loose sand left in the surfacing. This gives the maximum amount of hard sand to carry the traffic and the minimum amount of clay to bind it. More sand makes a less durable road and more clay makes one which becomes soft more rapidly when wet.

There is a great difference in the value of different clays for such work. Some of them become dough-like when mixed with a certain amount of water and can be molded into objects which retain their shape after drying. If these molded objects are immersed in water they will retain their form for a long time. These varieties are called "plastic clays" and the most plastic are called "ball clays." There are other varieties which fall to pieces more or less quickly when wet, as quicklime does, and they are therefore called "slaking clays." They are more easily mixed with sand than the plastic clays, but they have much less binding power and a road built with them is less durable when dry and more easily rutted when wet. The amount of clay to be used can be determined by a simple field test described as follows by Andrew P. Anderson:

> From typical samples of each of the available clays, test mixtures, varying by one-half part, are made with the sand so that each clay is represented by a set of mixtures ranging by successive steps from one part sand and three parts clay to four parts sand and one part clay. These are worked up with water into a putty-like mass and from each mix two equal quantities are taken and rolled between the palms of the hands into reasonably true spheres, labeled and placed in the sun to dry. When thoroughly baked, a set of spheres representing any one clay is placed in a flat pan or dish and enough water poured gently into the pan to cover them, care being taken not to pour the water directly on the samples. Some samples will begin to disintegrate immediately. Those breaking down most slowly contain most nearly the proper proportion of sand and clay for the particular materials. The relative binding power of the various clays may then be determined by comparing the hardness and resistance to abrasion of the various dry samples having the correct proportion of sand and clay, as determined by the water tests.

In February, 1917, representatives of 21 state highway departments and of the U. S. Office of Public Roads recommended the

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following mixtures for hard, medium and soft classes of sand-clay roads.

Hard class: Clay, 9 to 15 per cent; silt, 5 to 15 per cent; total sand, 65 to 80 per cent; sand retained on a 60-mesh sieve, 45 to 60 per cent.

Medium class: Clay, 15 to 25 per cent; silt, 10 to 20 per cent; total sand, 60 to 70 per cent; sand retained on a 60-mesh sieve, 30 to 45 per cent.

Soft class: Clay, 10 to 25 per cent; silt, 10 to 20 per cent; total sand, 55 to 80 per cent; sand retained on a 60-mesh sieve, 15 to 30 per cent.

By clay is meant material separated by subsidence through water and possessing plastic or adhesive properties; it is generally below 0.01 mm. in diameter. By silt is meant the fine material other than clay which passes a 200-mesh sieve and is generally from 0.07 to 0.01 mm. in diameter. By sand is meant the hard material which passes a 10-mesh sieve and is retained on a 200-mesh sieve, and is generally from 1.85 to 0.07 mm. in diameter.

The larger part of the following explanation of the construction of sand-clay roads was prepared by W. S. Keller, State engineer of Alabama, where many miles of sand-clay roads have been built and for light traffic are giving good satisfaction.

Every farmer who lives in a section of country where both sand and clay are prevalent, is more than likely traveling over a section of natural sand-clay road but is ignorant of the fact. He can call to mind some particular spot on the road he travels, though it may not be more than 100 feet in length, that is always good and rarely requires the attention of the road hands. Good drainage will be noticed at this place and if he takes the trouble to investigate, he will find that a good mixture of sand and clay forms the wearing surface. If this 100 feet of road is always good then the entire road can be made like it provided man will take advantage of the lesson taught by nature and grade the road so that the drainage will be good and surface the balance of the road with the same material. If it is not possible to find this ready mixed surfacing material convenient to the road it may be possible to find the two ingredients in close proximity. In case the road after grading shows an excess of sand, clay should be added, or in case clay predominates, sand should be added to produce good results. There are four general ways in which sand-clay roads may be built:

1. Ready mixed sand and clay placed on clay, sand or ordinary foundation.
2. Sand and clay placed on soil foundation and mixed.
3. Clay hauled on a sand foundation and mixed with the sand.
4. Sand hauled on a clay foundation and mixed with the clay.

Taking up the various methods in order:

1. A natural mixture of sand and clay can often be found where the two materials are found separate. The most important point is to know the natural mixture when seen. The very best guide to this is to find a natural piece of good road. A sample from the best of this good section will, by comparison, indicate what is required, close to the road to be sur-

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faced. This natural mixture of sand and clay can be noticed where red clay and sand crop out, usually well up in the hills, having in ditches and cuts the appearance of red sandstone. A good stratum of well mixed sand and clay will stand perpendicular in cuts and ditches, resisting erosion almost as well as sandstone. A test of the best natural sand-clay mixtures will show the sand forms about 70 per cent of the whole. The test is very simple. Take an ordinary medicine glass, measure 2 ounces of the mixture into the glass and wash out the clay. Dry the remaining sand and measure again on the medicine glass. The loss will be the amount of clay originally contained in the mass.

Before placing any sand-clay on the road, the road should be graded to the desired width. The surface of the graded road should be flat or slightly convex. The sand-clay should be put on from 8 to 12 inches in thickness, depending on the character of the subgrade or foundation. With a hard clay for foundation, 8 inches of sand-clay will suffice. If the subgrade is sand it is well to put on as much as 12 inches of the surfacing material. After a few hundred feet of surfacing material has been placed, a grading machine should be run over it to smooth and crown the road surface before the top becomes hard and resists the cutting of the blade. It is a good plan to turn the blade of the machine so as to trim the edges of the surface part, discharging the excess sand and clay onto the earth shoulders. After one round trip with the blade turned out, the remaining dress work with the machine should be with the blade turned in, with the exception of one trip down the center of road with the blade at right angles to the axis of the road for the purpose of distributing any excess of material left in the center.

After the machine work, it is well to follow with a drag, which smooths any rough places left by the machine and leaves the road with a smooth, even surface. A sand-clay road, unlike other roads, cannot be finished in a short space of time. It can be left in an apparently finished condition with a hard, smooth surface, but it will be found on close examination that the hard surface is in reality only a crust, below which there are several inches of loose material. After the first hard rain the crust softens, the road becomes bad and the work appears to be a failure. This, however, is just what is needed to make it eventually good. After the surface has dried until the mass is in a plastic state, it should be dragged until the surface is once more smooth, with proper crown, and should be kept this way by dragging at least once a day until the sun has baked it hard and firm. The mistake of keeping traffic off during this process of resetting should not be made. The continuous tamping of the wheels of wagons and hoofs of horses is just what is needed to compact the sand-clay into a homogeneous mass. The ordinary roller is not very effective in this work, but corrugated rollers have given excellent results. One type which is widely used has 18 cast-iron wheels weighing 300 pounds each, which compress the bottom of the mixture first. As the material becomes more and more compact the wheels ride higher and higher and finally the surface is so hard that the roller does not sink into it at all. A drag is an indispensable machine in the construction of any kind of sand-clay road.

2. Sand and clay placed on a soil foundation and mixed. This is necessary where the old road has neither a sand nor clay foundation and it is impossible to find the two ingredients ready mixed, but possible to get both in separate state near at hand. The clay should first be placed on the road to a depth of 4 inches and the required width. It is not wise to place more than a few hundred lineal feet of clay before the sand is hauled, as the clay rapidly hardens and makes the mixing process difficult.

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After, say, 400 feet of clay has been placed, the clay should be broken by means of a plow and harrow, if it has become hard, and sand to a depth of 6 inches placed on it. This should be plowed and harrowed in thoroughly. This is best done immediately following a rain, as the two can be more satisfactorily mixed. The traffic aids the mixing and should be encouraged on the road. After the mass appears to be well mixed, the road should be properly shaped, as previously explained. The road should be given watchful attention and should sand or mud holes appear, a second plowing and mixing should be given.

3. Clay hauled on a sand foundation and mixed with the sand. The mixing process is similar to that described under second head. It is only necessary to add that as the foundation is sand, a little more clay will be necessary than where the foundation is of clay or soil.

4. Sand hauled on a clay foundation and mixed with clay. The clay foundation should be plowed to a depth of 4 inches and harrowed with a disk or tooth harrow until the lumps are thoroughly broken or pulverized. Sand should then be added to a depth of 6 inches and mixed as before described.

Sand and clay can be mixed best when wet, but as most road construction is done in the summer months, it is necessary to do most of the mixing dry and keep the road in shape after the first two or three rains, while the passing wagons and vehicles give the road a final wet mixing. A sand-clay road is the cheapest road to maintain, for the reason that it can be repaired with its own material. With a drag or grading machine ruts can be filled with material scraped from the edges, whereas on gravel or macadam roads, this is not possible. The repairing of these roads can be done almost exclusively with the drag, only enough hand work being required to keep the gutters open and the growth of weeds cut on the shoulders. Holes are repaired by adding more sand-clay, and when many of them appear fresh sand-clay should be spread over the surface of the road. If the road gets into really bad condition, the roadbed should be plowed up, reshaped and fresh sand-clay added. This is unnecessary where the road is maintained properly and the travel is not too heavy for the type of construction.

Conclusions

Just what are the objections to sand-clay roads and what are the good features? Certainly there are both else there would not be counties that have discontinued the construction of such roads and others that are perfectly satisfied with this homely highway.

Unfortunately little consideration has been paid the character and volume of traffic before the type of road is decided on. What unquestionably is good for the rural districts is not necessarily suitable for populous sections, yet some road commissioners consider a road is a road and if it is good in one place it must be good in another. Acting on this false hypothesis sand-clay is used for surfacing roads through populous areas and even the streets of towns and cities with the inevitable result of dissatisfaction. Truly sand-clay is good in its place, but it must be kept there. That such roads should be condemned entirely is unreasonable and to say the least shows bad judgment. For a county road carrying a reasonable amount of traffic daily, reason-

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able in tonnage as well as number of vehicles, this road is quite satisfactory.

The principal objections offered are that it becomes sloppy in wet weather and dusty in dry weather. That some roads do become sloppy cannot be denied. The depth of ruts depends to a very great extent on the character of the sand-clay surfacing and the amount of maintenance such roads have had. Too much care cannot be exercised in the selection of this surfacing material and the mixing, where mixing is required. Often varying sections of good and bad surfacing can be seen in one continuous piece of road not exceeding two miles in length, showing clearly no judgment was exercised in the selection or test of material. One of the things experience has taught us is that one of the best ways to ruin what would be a good sand-clay road is to crown it to death, and literally this is true. The road is killed and its remains are washed into the side ditches leaving only its ribs for a driving surface.

The nature of the material, 65 to 80 per cent being sand, should be a warning against such practice. Just sufficient crown to permit the water falling on the road to shed gently, is good practice. Alabama standard sections provide for a fall of ½ inch to the foot from center of road to edge of road bed and 1 inch to 4 inches from this point to center of ditch. The importance of having a good wide shallow ditch rather than a narrow deep barrel shaped ditch cannot be to strongly emphasized. Sand-clay roads are, of course, in sections where the soil has a large percentage of sand in it and naturally such soil washes easily. The broad ditch lessens the tendency of deep erosion and side washes, besides eliminating danger to the travelling public.

Another lesson we have learned is that a good width means long life to this character of road. Our standard width of crown is 24 feet, and our width of ditches 6 feet. We provide for a variation in the width of ditches according to soil condition, but generally the width is fully 6 feet. Grassing slopes is very important. Bermuda grass grows well in sandy soil and is the salvation of washing fills. It should not be planted on shoulders, especially in cuts as it grows rapidly and will soon choke up the ditches.

One of the good features of the sand clay road is that it is less expensive than any other kind of surfaced road, the material for construction and maintenance being close at hand. Another good feature is that a well maintained road of this kind is most pleasing to all kinds of traffic.

Unquestionably the objectionable feature most often complained of, that is "sloppy," can be reduced to a minimum by the frequent use of a drag during wet weather.

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GRAVEL ROADS

By CHARLES J. BENNETT,

State Highway Commissioner of Connecticut

In spite of the fact that a tremendous amount of money is being spent in the construction of State and Federal highways throughout the United States, there must remain a tremendous number of miles of highway which cannot be improved by either one of these agencies. These highways at the present time are, many of them, constructed of inferior material even where deposits of good material are available.

It is evident that the improvement in methods of transportation demand an improvement in the type of road constructed on the ordinary highway, and for this purpose there can be no material so nearly universal and so satisfactory as gravel. There are few sections of the country where gravel is not available, and there are few roads which could not be improved by the use of gravel intelligently applied.

Types of gravel road vary between very wide limits. In general, they may be classified under three heads; namely, the roads built of gravel by the feather edge method; the road built of gravel by the trench method, and the road built of screened gravel. These types are classified in the order of their cost of construction, the feather edge method road being the cheapest type. The cost increases as refinements are added in the construction of the road.

In places where considerable gravel occurs, it is possible to build roads by either one of the first two methods without doing very much work on the material, but where the material is unsatisfactory or where a higher type of construction is necessary, the use of screened gravel is advised.

In general, roads of this type are easily repaired where the material is available and of the same character of which the road was originally built. It is comfortable to pass over, and unless subjected to excessively heavy traffic, is one of the most satisfactory types of road at present known.

It is impossible to give an average cost of construction for roads of this type, as methods of construction are different, and the cost of labor and material varies in different sections of the country.

Gravel for road building purposes should consist of material formed from hard stone particles. It should not contain too much loam or clay, probably not in excess of from 8 to 15 per cent of this material in case the road is not to be treated with

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bituminous coating. If treated with bituminous coating, a gravel road should be free from clay or loam, and should present to the bituminous material a clean, sharp sand and gravel surface.

The above statement gives rise to a general division in the construction of gravel roads under two heads: First, those gravel roads which are not to be treated; and, second, those that are. When a road is not to be treated with bituminous material, it should contain, as stated above, from 8 to 15 per cent of binding material, while in the second case, binding material should be entirely eliminated and the road made up of porous material which would allow the bituminous surface to secure a firm grip on the stone particles.

Roads of this type are easily repaired. At the same time they are easily destroyed when subjected to heavy and fast travel. In other words, when the travel increases beyond what is known as a light amount of traffic, the road should be included in the State highway type of construction and built with a heavier and stronger surface.

The ordinary maintenance of gravel roads on the lighter traffic roads can easily be taken care of with a split log drag or some modification of this instrument. The drag should be used continuously and immediately after rain storms or when the winter is over and the frost is coming out of the ground.

The reconstruction of gravel roads should be done in the spring when the road is soft and new material can be easily incorporated with the old.

The cost of maintenance varies between wide limits. This variation is due to the variations in the kind and weight of traffic, the character of gravel, the width of the road and the climate in which it is built.



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WATER-BOUND MACADAM ROADS [1]

Water-bound macadam roads are adapated to highways carrying moderate traffic, for experience shows that even when a large part of the traffic is motor-driven this type of construction can be maintained successfully by surface applications, as described in a later chapter. Where a gravel road is not quite able to carry the traffic, a macadam top course on a gravel base has been adopted as a standard type by the highway departments of a number of States.

Stone

The ideal rock for the construction of a water-bound macadam road resists the wear of traffic to which it is subjected to just that extent which will supply a sufficient amount of cementitious rock dust to bind or hold the larger fragments in place. It is generally admitted that the ordinary macadam road is not well suited to any considerable amount of automobile traffic, because such traffic rapidly removes the binder without producing fresh material to take its place.

Cementing value is a necessary quality for rocks used in water-bound macadam road construction. As determined by test, cementing values below 25 are called low; from 26 to 75, average, and above 75, high. In general, the cementing value should run above 25. For rocks which show a low French coefficient of wear, however, a relatively high cementing value is more necessary than for those which have a high French coefficient. Interpretation of results of the cementing value test is subject to a number of influencing considerations. For instance, it has been found that certain feldspathic varieties of sandstone give excellent results in this test, while experience has shown that they do not bind well when used in the wearing course of macadam roads. In the case also of certain varieties of the trap group, low results are frequently shown by laboratory tests for rocks which bind quite satisfactorily upon the road, provided traffic is sufficiently heavy to supply the requisite amount of fine material. Certain granites, gneisses, and schists which are not suitable for use as binding material give good results in this test. In such cases it is usually found that the highly altered nature of the material reduces its toughness and resistance to wear to such an extent as to condemn it for use.

[1] (Revised by A. W. Dean, Chief Engineer Massachusetts Department of Public Works and D. K. Jackson, Sr., Assisting Testing Engineer, Bureau of Public Roads, United States Department of Agriculture.)

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Experience has shown that in general the following table of limiting values for the French coefficient of wear, toughness, and hardness may be used in determining the suitability of a rock for the construction of the wearing course of a macadam road:

Limiting Values of Physical Tests of Rock Suitable for Water-bound Macadam

Travel	French Coefficient	Percentage of Wear	Toughness	Hardness
Light	5 to 8	5 to 8	5 to 9	10 to 17
Moderate	9 to 15	2.7 to 5	10 to 18	Over 14
Heavy	Over 15	Under 2.7	Over 18	Over 17

With relation to the limitations for hardness it may be noted that when any given value for toughness falls within certain limits which define the suitability of the material for macadam road construction under given traffic conditions, the corresponding value for hardness will fall within similar limits for hardness. In this connection it will be seen in the table that a maximum limit for hardness is only given in the case of light traffic. It has been found that the great majority of samples having a French coefficient of wear of from 5 to 8 and a hardness of over 17 are granites, quartzites, and hard sandstones, which are unsuited for use in the wearing course of water-bound macadam roads because of their lack of binding power.

The weight of a cubic yard of crushed stone varies considerably, depending upon the rock, the size to which it is broken and the amount of shaking the sample receives before its volume is measured. The range in weight of a cubic foot of solid rock is 162 to 221 pounds for trap, 165 to 200 pounds for schist, 156 to 175 pounds for felsite, 156 to 193 pounds for quartzite, 125 to 193 pounds for limestone, and 125 to 187 pounds for granite. The total range from the lightest limestone to the heaviest trap is over 75 per cent and the crushed rock will show the same variations. Consequently, when broken stone is bought by weight it should be actually weighed before estimating the quantity required for good work.

Crushed stone is the most important branch of the stone industry. The production of this material for road building in the different states is given in a table in Part III of this book. The requirements for railroad ballast and concrete as well as for road work are so large that commercial broken stone is available

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in many parts of the country at a lower price than the cost of quarrying and crushing local material. It is sometimes economical, even at a greater initial cost, to import stone from a distance if thereby a more durable road may be had than is possible with the use of local stone.

Much of the stone is crushed locally, usually in portable plants. These comprise a crusher with an engine and boiler, revolving screens, portable bins and an elevator to lift the stone after it is crushed into the screen and sometimes into the bins. The capacity of a crusher should be adjusted to the road roller capacity. If the crusher furnishes more stone than the roller can consolidate, it is too large to work economically. If the crusher can not supply enough stone to keep the roller at work, the latter will operate uneconomically. Furthermore, the arrangements for supplying stone from the crusher to the road must be such that the expensive equipment at each end of the line will be kept operating all the time. There is some difference of opinion as to the proper capacity of a crusher, for in some sections of the country it is held that from 60 to 80 cubic yards of broken stone is as much as a single roller will consolidate properly, while in other sections it is held that a roller which does not consolidate 75 tons per day is not doing good service.

Where the stone supply is limited to ledges at infrequent intervals but little choice in the location of the crushing outfit is possible. If field stone or ledges are available alongside the road at frequent intervals a crusher can serve about two miles of road most economically. Local conditions, however, affect the proper arrangement of the plant so greatly that no precise rules can be drawn up. It occasionally happens that the availability of water for the boiler is of more importance than any other factor in determining the location of the outfit.

If possible, the crusher should be set low enough so that a platform can be built at the level of the opening into which the stone is dumped. The carts are driven onto this platform and the material is handled most economically in this manner. The men who set up the plant should have had experience in this work. Much depends on the proper alignment of the several parts and the delays in operation will be avoided if the work is done properly in the first instance.

The screens in such portable plants have three sections about 4 feet long and 30 inches in diameter. The first section has perforations which are ½ inch in diameter. The perforations of the second section are generally 1¼ inches in diameter where comparatively hard stone is used and 1½ inches in diameter where softer stone is employed. With the very soft stone used in some

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of the Central States, the perforations are sometimes 2½ inches, and the third section of the screen is omitted. The perforations in the third section are from 2 to 2½ inches in diameter as a rule, depending upon the maximum size of the stone which is allowed in the road, but this maximum size varies widely in different States. In New York stone up to 3½ inches in size is used in the bottom course and in Ohio pieces of sandstone as large as 6 inches in their longest dimensions are permitted in the bottom course of some roads. Stone passing a 4-inch circular opening is also permitted under some conditions. In Wisconsin the bottom course is usually made of stone 2 to 3½ inches in size; in this case the perforations in the screen are ½, 2 and 3½ inches.

The stones too large to pass through the openings in the third section of the screen drop out and are run through the crusher again. There is sometimes a conveyor to carry these tailings from the end of the screen to the crusher. The jaws of the crusher should be set to give as few tailings as possible and the length of the screen sections should be adjusted to accomplish the same purpose. The operation of the screens should be observed from time to time in order to make sure that material which should pass the openings in each section does not flow along the screen so rapidly that there is a failure to separate it out by the right section of the screen. If the screen revolves too rapidly fine material will be carried into the coarser grades. Stone purchased from commercial crusher plants is often observed to run small, the best separation occurring in the product which is obtained during a time of minimum demand. This is because more time is then given to the stone in its passage through the screens. It is impracticable to obtain a complete gradation of the sizes of stone and for this reason highway engineers often permit variations from the nominal maximum and minimum dimensions of any size. For instance the ¾-inch stone specified in New Jersey may contain up to 5 per cent of material larger than 1¼ inch and up to 8 per cent smaller than ⅝ inch, although the nominal range of size is from ⅝ to 1¼ inch.

There is no uniformity in the designation of the sizes of crushed stone; what is termed as No. 1 stone in Ohio is entirely different from No. 1 stone in New York.

Drainage

The investment in a macadam road is so great that every precaution should be taken to have the roadbed thoroughly drained. The methods of doing this are explained in the chapter on drainage. If they are not employed wherever necessary the road will

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inevitably become rutted and marked by holes during prolonged wet weather, and the maintenance of such places will entail an annual expenditure far greater in the end than the cost of proper drainage work.

Formerly Telford foundations were used in all wet, soggy ground under well-built broken stone roads, but experience has shown that with good underdrainage equally satisfactory foundations can be built of coarse gravel. This is dumped on the bottom of the road after the soft material has been excavated to a considerable depth. The mass of gravel should be drained into the side ditches by constructing blind drains through the shoulders at intervals of not over 50 feet.

Where suitable field stone is available for a Telford foundation it is still sometimes used. The New York requirements for stone for this purpose are a thickness of not less than 1½ inches, a depth equal to the depth required for the foundation, from 6 to 8 inches, and a length not more than one and a half times the depth. The New Jersey specifications require stone 5 to 10 inches long, 2 to 4 inches wide and at least 6 inches deep. Some engineers advise placing this stone on a bed of gravel, while others believe that if gravel is available it is best to make the entire base of it and not employ Telford, since the latter is quite expensive. The stone must be set on their broader base, lengthwise across the road, and wedged by driving small stone into the interstices. The projecting points should be broken off with a stone hammer, the depressions in the top filled with stone chips, and the foundation rolled.

The V-shaped drain is a substitute for a Telford foundation which has received much favor in some States.

Sub-Grade

It is necessary to place the stone for a macadam road in a box or trench in order to roll it successfully. The bottom must be slightly crowned. This is for two reasons; first to shed any water which may sink through the macadam, and second, to keep the amount of stone required for the road to the minimum actually necessary. The sub-grade must be rolled until hard in order, first, that the stone placed on it can not be driven into it and thus serve no useful purpose, and second, to turn toward the sides of the road, into the blind drains leading to the ditches, any water which may penetrate the courses of stone.

The depth of the box or trench is fixed by the desired depth of the macadam roadway. This is rarely less than 6 inches at the center and is sometimes considerably more, although there is a

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question whether a greater thickness than 8 inches after rolling serves any useful purpose. The harder and tougher the stone, the less need be the thickness of the road, provided the sub-grade is firm. Usually the sides of the macadam roadway are 1 to 2 inches thinner than the center.

On very sandy soils, to keep the sand from working up through the stone, a covering of clay, hay, straw, or fine brush is spread over the sub-grade.

Placing the Broken Stone

It is customary to begin placing the broken stone as soon as a few hundred feet of the sub-grade has been prepared to receive it, because it is undesirable to expose the rolled earth surface to the danger of drenching by rains for a longer period than is necessary.

The first course is rarely if ever spread to a greater depth than 6 inches when loose, because a roller cannot compact a deeper course of stone in a satisfactory manner. The thickness is seldom less than 4 inches. The largest size of the screened stone is used. In some states it is forbidden to dump the stone directly on the sub-grade, on the ground that this leaves a mass of consolidated small stone in the center of the heap which remains almost intact when the pile is leveled. Accordingly the stone must be deposited on dumping boards about 6 feet long and 3 feet wide, from which it is shoveled to the sub-grade. This is no longer a generally adopted requirement, however, but it is not unusual to require a load to be deposited in several dumps so that the least amount of shoveling and raking will be required.

The easiest method of distributing the stone is by using an automatic spreader wagon which deposits it in a layer of approximately the right thickness.

When a hundred feet or so of the first course has been spread, the rolling should begin. A roller weighing about 600 pounds per inch of width of roll is usually recommended for rolling hard rock, but one of three-fourths this weight will probably do better work with soft limestone. The roller starts at the ends of the stone and care should be taken that the shoulders are not crushed during the trips near the sides of the trench. The roller should not be run much faster than 100 feet per minute. After both sides are moderately firm, the roller should move gradually toward the center until the whole lower course is thoroughly compacted. The rolling should be stopped as soon as the pieces of stone begin to break. Sometimes it is found that a wavy motion continues and the stone will not compact.

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Cost Per Mile Corresponding to Different Costs Per Square Yard, Based on Table Published by the Commissioner of Public Roads of New Jersey

Width, Feet Square Yards, Per Mile	8 4,693⅓	10 5,866⅔	12 7,040	14 8,213⅓	16 9,386⅔	18 10,560	20 11,733⅓
Cost Per Square Yard							
$0.25	$1,173.33	$1,466.67	$1,760.00	$2,053.33	$2,346.67	$2,640.00	$2,933.33
0.30	1,408.00	1,760.00	2,112.00	2,464.00	2,816.00	3,168.00	3,520.00
0.35	1,642.67	2,053.33	2,464.00	2,874.67	3,285.33	3,696.00	4,106.67
0.40	1,877.33	2,346.67	2,816.00	3,285.33	3,754.67	4,224.00	4,693.33
0.45	2,112.00	2,640.00	3,168.00	3,696.00	4,224.00	4,752.00	5,280.00
0.50	2,346.67	2,933.33	3,520.00	4,106.67	4,693.33	5,280.00	5,866.67
0.55	2,581.33	3,226.67	3,782.00	4,517.33	5,162.67	5,808.00	6,453.33
0.60	2,816.00	3,520.00	4,224.00	4,928.00	5,632.00	6,336.00	7,040.00
0.65	3,050.67	3,813.33	4,576.00	5,338.64	6,101.33	6,864.00	7,626.67
0.70	3,285.33	4,106.67	4,928.00	5,749.33	6,570.67	7,392.00	8,213.33
0.75	3,520.00	4,400.00	5,280.00	6,160.00	7,040.00	7,920.00	8,800.00
0.80	3,754.67	4,693.33	5,632.00	6,570.67	7,509.33	8,448.00	9,386.67
0.85	3,989.33	4,986.69	5,984.00	6,981.33	7,978.67	8,976.00	9,973.33
0.90	4,224.00	5,280.00	6,336.00	7,392.00	8,448.00	9,504.00	10,560.00
0.95	4,458.67	5,573.33	6,688.00	7,802.67	8,917.33	10,032.00	11,146.67
1.00	4,693.33	5,866.67	7,040.00	8,213.33	9,386.67	10,560.00	11,733.33
1.05	4,928.00	6,160.00	7,392.00	8,624.00	9,856.00	11,088.00	12,320.00
1.10	5,162.67	6,453.33	7,744.00	9,034.67	10,325.33	11,616.00	12,906.67
1.15	5,397.33	6,746.67	8,096.00	9,445.33	10,794.67	12,144.00	13,493.33
1.20	5,632.00	7,040.00	8,448.00	9,856.00	11,264.00	12,672.00	14,080.00

NOTE.—When the cost per square yard is greater than $1.20, the corresponding cost per mile can be found by adding to the tabulated cost for a rate of $1.00 per square yard, the tabulated cost for a rate equal to the difference between the given rate and $1.00. The costs per square mile for widths greater than 20 feet are found by adding together the costs for two of the tabulated widths which will give the desired width.

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This may be due to a wet sub-grade, which will probably give no trouble if allowed to dry for a day or two, or it may be due to the use of a very hard stone, when the application of a little sand or fine gravel may remedy the difficulty. With some soft, coarse gravel stones a crawling motion may be noticed, which can be prevented by a light sprinkling of coarse sand, stone screenings and sometimes by water. The rolling is continued until the stone has no movement when the men walk over it. If depressions develop during the rolling they must be filled with stone of the same size as that used in the course and rolled until firm.

Some engineers advise harrowing the loose stone with a spike-tooth harrow in order to mix the stone thoroughly and to save a part of the rolling. This would be of advantage if full loads of stone were dumped directly on the subgrade, for it would break up the cores of small stone in the center of the piles. Other engineers recommend using a blade grader to shape the loose stone just before rolling.

It is not customary to apply a binder of gravel or screenings to the bottom course in some States and it is not required in others. It is apparently a detail depending considerably upon the hardness of the stone used. If the stone is relatively soft and the bottom course is constructed of a large size of stone, a binder may prevent the internal disintegration of the stone under loads to some extent, but without somewhat smaller, hard trap rock used in Massachusetts, for instance, screenings are unnecessary.

After about a hundred feet of the bottom course has been rolled, the second course is spread. This consists of the size from ½ to 1¼ or 1½ inches, and the loose depth is 3 to 5 inches. Large loads should not be dumped directly on the bottom course. The top course is usually given its final shaping with rakes. This course is rolled commencing on each outer edge with the rear wheel half on the stone and half on the shoulders; the roller is gradually worked toward the center. If depressions are developed during this work, they must be filled, and the rolling should continue until the surface is hard and uniform in contour.

The surface is then covered with the binder. The material used for this purpose varies with the character of the stone in the top course. Generally screenings are employed, but in States where the top course is composed of rather large sizes of stone the screenings have small stone mixed with them. In Maryland limestone screenings are not permitted with trap rock without the consent of the engineer. A. R. Hirst, State highway engineer of Wisconsin, advises using a clayey pea gravel or disintegrated

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granite with crushed quartzite or granite, and if these are unavailable he prefers a bituminous binder.

Screenings are rarely if ever permitted to be dumped on the road. They should be placed in piles along the road at such intervals that they can be distributed readily and enough material will always be available. In Massachusetts it is not customary to place the screenings to a greater depth than 1 inch. In Michigan the depth is about ¾ inch and in Wisconsin about ½ inch on State roads.

Although the screenings are sometimes rolled dry, after being spread, the usual practice is to sprinkle the road with water before rolling. The road must be sprinkled until the screenings are thoroughly wet and do not stick to the wheels of the roller. Where hard, small stone is used in the top course more water is generally employed than where the stone is larger, and an attempt is made to flush the screenings into the interstices between the stones. If the screenings are picked up by the roller at any time, more water must be applied. The sprinkling and rolling is continued until water is carried along in front of the roller wheels at every point of the road.

Rolling must be done carefully, for the appearance of the road will depend upon this work.

After the road has dried sufficiently, the shoulders should be smoothed off with a road machine, if one is available. The shoulders should be trimmed so the water can flow from the center of the road to the ditches along every foot of the way. All surplus material should be removed, and the shoulders should be rolled as far out as it is safe to run the roller.

Maintenance

Where there is very little automobile traffic the old-fashioned methods of maintenance are still applicable. If the road was built late in the fall, particularly if trap rock was used, it is possible that loose stone will appear on the surface in the spring. They should be removed and need cause no apprehension. Holes and ruts should be filled with small stone and screenings, preferably during a rain, so that the traffic will begin to bind the patch as soon as the weather clears. When the top course has been worn down so that the large stone of the bottom course show in places, the road should be repaired. If the top course is to be more than 3 inches thick the stone can be spread on the road and treated like the top course of a new road. If the course is to be made of less than 3 inches or less stone, it is generally best to loosen up the road by means of spikes placed in the wheels of a roller or by the use of a scarifier.

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This method of maintenance is practically obsolete on account of motor traffic. The shearing action of the wheels of an automobile on a water-bound road speedily loosens the stones of the top course and it is necessary to protect the surface by a tenacious mat of bituminous material and stone. Experience shows that this should not be applied until the road has seasoned for a few months. If the road is finished late in the fall, so that no opportunity will be afforded for it to season before winter closes down construction work, the surface can be bound with calcium chloride to hold it until spring, when the bituminous mat can be applied.

The ordinary method of maintaining the road is to clean it thoroughly and then apply a road oil uniformly over the surface. Some of these oils are so thin that they soak into the surface, while others must be covered with sharp sand or screenings free from dust. The methods of doing the work are explained in the chapter on surface applications.



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FLUID PETROLEUM PRODUCTS [1]

A large part of the materials used as dust preventives and binders to hold together the mineral constituents of roads are obtained from petroleum. Petroleum is a term which covers mineral oils of a great variety of characteristics, all alike in being composed of a great variety of complex chemical compounds called hydrocarbons, of which there are a very large number. The investigation of the properties of these hydrocarbons and their derivatives require a knowledge of organic chemistry which few roadbuilders possess, and because some of them have attempted to tread the veritable mazes of this extremely complicated domain of chemistry, no little confusion has arisen. The main facts regarding petroleum and the other hydrocarbons used in roadbuilding are definitely known, but the details of any group of these compounds are best left for the chemical specialist, who is making steady progress in his researches concerning them.

Paraffin and Asphaltic Oils

The roadbuilder's interest in petroleum is largely in its base, a term used to designate a part of oil left after distilling off the more volatile portions. The base is sometimes made up of compounds of the paraffin group or series, as chemists term such allied compounds. Marsh gas is a member of the paraffin series, and its least complex representative. A few other members are gases, but most of them are liquids or solids, and their number is legion. The base of other petroleums is made up of compounds called polycyclic polymethylenes by the chemist, and as these compounds occur in native asphalts such a base is called asphaltic. The base of other petroleums is made up of both paraffin and asphaltic compounds and such petroleums are called semi-asphaltic.

The gaseous hydrocarbons are of no interest to the roadbuilder. The liquid and solid hydrocarbons are what determine the value of petroleum for his purposes. The liquid and solid paraffins are greasy materials without binding properties, while the asphaltic materials are sticky. Consequently the roadbuilding value of petroleum depends upon the asphaltic compounds in its base.

Paraffin oils have been used successfully as dust preventives when sprinkled in small quantities on a clean road, but if used in large quantities they form a dirty, greasy surface and seem to lubricate the pieces of stone in the road, which becomes rutted rapidly.

[1] Revised but not rewritten by The Asphalt Association.

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Petroleum is obtained from many districts, which are called fields in the industry. The leading fields, which supply or have supplied materials for roadbuilding in the United States, are described substantially as follows:

1. The Appalachian field embraces all oil pools east of central Ohio and north of central Alabama, including those of New York, Pennsylvania, West Virginia, southeastern Ohio, Kentucky, Tennessee, and northern Alabama. The oils of the Appalachian field are in the main of paraffin base, free from asphalt and practically free from sulphur, and they yield by ordinary refining methods high percentages of gasoline and illuminating oils—the products in greatest demand.

2. The Lima-Indiana field embraces all areas of oil production in the northwestern part of Ohio and in Indiana. The petroleum of the Lima-Indiana field contains some asphalt, though consisting chiefly of paraffin hydrocarbons with sulphur compounds.

3. The Illinois field lies in the southeastern, south-central and western parts of the State, comprising about 16 counties. Illinois oils contain varying proportions of both asphalt and paraffin and differ considerably as to specific gravity and distillation products. Sulphur is generally present.

4. For commercial purposes it is customary to group under the title "Mid-Continent field" the areas of oil production in Kansas, Oklahoma, northern and central Texas, and northern Louisiana. Mid-continent oils vary in composition within wide limits, ranging from asphaltic oils poor in gasoline and illuminants, to oils in which the asphalt content is negligible and the paraffin content relatively high and which yield correspondingly high percentages of the lighter products on distillation. Sulphur is present in varying quantities in the lower grade oils.

5. The term "Gulf field" includes that portion of the gulf coastal plain of Texas and Louisiana in which petroleum is found in domes, associated with rock and salt gypsum. Oils from the Gulf field are characterized by relatively high percentages of asphalt and low percentages of the lighter gravity distillation products. Considerable sulphur is present, much of which, however, is in the form of sulphurated hydrogen and is easily removed by steam before refining or utilizing the oil as fuel.

6. The California field is mainly located in Kern, Fresno, Orange, Santa Barbara and Los Angeles Counties. The California oils are generally characterized by much asphalt and little or no paraffin and by small portions of sulphur. The chief products are fuel oils, lamp oils, and oil asphalt.

7. The Rocky Mountain field embraces all areas of production

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of petroleum in Colorado, Wyoming and Montana, as well as a number of acres of prospective production in Utah and New Mexico. Oils from Wyoming and Colorado are in the main of paraffin base, suitable for refining by ordinary methods. Heavy asphaltic oils are also obtained in certain of the Wyoming fields.

8. Mexican field. This extends along the Gulf of Mexico from the vicinity of Tampico to the vicinity of Tuxpan, and produces asphaltic and semi-asphaltic petroleum.

9. Trinidad field. Asphaltic petroleum is also produced on the island of Trinidad.

Clifford Richardson gives the following explanation of the relation between this petroleum and Trinidad asphalt:

> Rising from the sands in which it occurs and coming in contact with the colloidal clay forming a portion of the mud existing below the crater or depression which holds the asphalt, it is emulsified with it and converted into the material which we recognize as Trinidad lake asphalt.

Refining Petroleum

Crude asphaltic petroleum has been used as a dust preventive and as a binder for road purposes, but generally the petroleum is refined to obtain a number of valuable materials occurring in it. The crude oil is first allowed to settle in tanks in which the mineral matter and water are separated from the oil. The latter is drawn off into cylindrical stills set horizontally in brickwork like

Petroleum Marketed in the United States in 1917 *by Fields*

(John D. Northrop, in *Mineral Resources of the United States*, 1917.)

Field	Quantity (Barrels of 42 Gallons)	Value	Average Price Per Barrel
Appalachian	24,932,205	$ 77,786,495	$3.120
Lima-Indiana	3,670,293	7,102,326	1.935
Illinois	15,776,860	31,358,069	1.988
Mid-continent	163,506,205	282,796,124	1.730
Gulf	24,342,879	26,087,587	1.071
California	93,877,549	86,161,764	.918
Rocky Mountain	9,199,310	11,322,248	1.231
Other fields	10,300*	20,600*	2.000
	335,315,601	$522,635,213	$1.559

*Includes Alaska and Michigan.

Note.—The imports of petroleum and petroleum products from Mexico in 1917 are reported by John D. Northrop as 29,933,516 barrels which are valued at $16,137,130.

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boilers. There is a furnace below the still, and the latter contains steam coils and sometimes steam jets at the bottom of the stills. The vapors from the stills are removed to condensers and liquefied.

The distillate that is obtained until the temperature reaches about 300°F. and the specific gravity of the product is about 0.73 is refined to furnish gasoline and naphtha. While the temperature in increased from 300° to 575° F., the specific gravity of the distillate increases to about 0.82, and the oil produced during this stage is treated to supply kerosene. If it is desirable to produce as much kerosene as possible, the furnace is heated and the sides of the still kept as cool as possible, so that some of the heavy vapor driven off in the bottom of the still will condense in the top and fall back into the much hotter material at the bottom, "cracking" these heavy vapors into lighter compounds. One result of such cracking is often the liberation of free carbon, which settles into the material in the bottom of the still. Asphaltic oils can be cracked at a lower temperature than paraffin oils.

If road oils for surface treatment are desired, the distilling process is stopped after the light distillates are driven off. The thick oil left in the still is called the residuum, and some people look upon it as a by-product and the name "residuum" as having a somewhat derogatory signification. As a matter of fact the residuum obtained in distilling some petroleums is by far the most important product obtained from them. Some Californian and Mexican oils contain such a large amount of asphaltic compounds and so little light oils that by stopping the refining process when the residuum has the consistency desired for some classes of paving materials, it is unnecessary to add any other bitumen to fit it for use.

In the patented Trumbull process, the oil is heated and then allowed to flow down the inner surface of a large vertical heated cylinder. The vapors are drawn from the top of the cylinder and the asphaltic residuum is collected at the bottom. The temperatures used and the rate at which the crude oil is fed to the top of the cylinder fix the consistency of the residuum.

One of the earliest attempts to improve the process of refining petroleum so as to yield the maximum quantity of products useful for paving was made by Dubbs. By adding sulphur to the residuum while it was at a high temperature he produced materials which have been widely used as fluxes. About the same time Byerly found that by blowing air through the heated residuum asphaltic products were obtained, the oxygen performing the same function as the sulphur used in the Dubbs process. Some of these blown-oil products have been used as fluxes and others

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have been used for a great variety of purposes. Some asphaltic oils furnish a residuum which does not require blowing to obtain road material, but this treatment is generally employed with semi-asphaltic oils when such a product is desired.

Fluxes

Fluxes are petroleum products which are mixed with harder bituminous materials to soften them to any desired consistency. Petroleum with a paraffin base furnished the first flux used in the asphalt paving industry.

Asphaltic or semi-asphaltic flux is the residuum left on distilling petroleum having an asphaltic or semi-asphaltic base to a point where the residuum is a dense liquid when cool but further distillation will produce a solid residuum when cold. It is characterized by a relatively low amount of saturated hydrocarbons. While it resembles natural maltha in some respects, it differs in remaining soft after heating to 400°F., most malthas becoming hard pitches after such treatment.



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ASPHALTS[1]

The following definition of "asphalt" has been adopted by the American Society for Testing Materials:

Solid or semi-solid native bitumens, solid or semi-solid[2] bitumens obtained by refining petroleum, or solid or semi-solid bitumens which are combinations of the bitumens mentioned with petroleums or derivatives thereof, which melt upon the application of heat and which consist of a mixture of hydrocarbons and their derivatives of complex structure, largely cyclic and bridge compounds.

This definition is dependent upon the same society's definition of "bitumens," which is:

Mixtures of native or pyrogenous hydrocarbons and their non-metallic derivatives, which may be gases, liquids, viscous liquids, or solids, and which are soluble in carbon disulphide.

These definitions were prepared after numerous conferences of road engineers and producers of materials, and are in very general use.

Roadbuilders use the term "natural asphalts" to designate the native solid or semi-solid asphalts, and "oil asphalts" to designate the corresponding materials prepared from petroleum or maltha. Some producers of oil asphalts object to the term on the ground that the material obtained by distilling away the lighter parts of asphaltic petroleum is as "natural" as that obtained by refining native asphalts. By "rock asphalt" is meant sandstone and limestone impregnated with asphalt or maltha. "Asphaltic sands" are mixtures of asphalt or maltha and sand, the latter in loose grains which fall apart when the bitumen is extracted; many of them are called rock asphalts because in their natural condition the maltha cements them into a rock-like mass.

The sources of the asphalts used in the United States are given in the accompanying table. The quantities of materials there stated were not all used for road and street purposes, as there are many other uses to which some of them are put.

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[1] Revised but not rewritten by The Asphalt Association.

[2] Solid bituminous materials are those having a penetration at 25°C. (77°F.) under a load of 100 grams applied for five seconds, or not more than 10. The significance of "penetration" is explained on page 314.

Semi-solid bituminous materials are those having a penetration at 25°C. (77°F.) under a load of 100 grans applied for five seconds, of more than 10 and a penetration under a load of 50 grams applied for 1 second of not more than 350.

Liquid bituminous materials are those having a penetration at 25°C. (77°F.) under a load of 50 grams applied for one second or more than 350.

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Statistics indicate that the primary influence of the war on the asphalt industry of the United States has been one of stimulation, especially so in the case of asphalts derived from petroleum.

American Production and Importation of Asphaltic Materials, 1917

(Compiled from report by John D. Northrop in *Mineral Resources of the United States*, 1917. Output stated in tons of 2000 pounds, except in case of imports, which are in tons of 2240 pounds)

	1917	
	Tons	Value
American bituminous rock	41,919	$136,255
Wurtzelite (elaterite), gilsonite	34,349	495,489
Grahamite	‡4,618	103,180
Total American natural bituminous material	80,886	734,924
American road oils and fluxes	374,667	3,722,711
American oil asphalts and pitches	327,142	4,011,980
Total American road oils, asphalts, etc	701,809	7,734,691
*Mexican road oils and fluxes	307,128	2,784,661
*Mexican oil asphalts and pitches	338,485	4,657,152
*Total Mexican road oils, asphalts, etc	645,613	7,441,813
Imports of asphalt:		
†Trinidad	98,458	553,969
Bermudez	52,165	263,600
Cuba	4,210	33,552
Barbados	51	4,855
Mexico	5,171	94,594
England	1,784	11,370
Canada	88	5,889
Columbia	120	5,271
Other British West Indies	5,762	24,568

*Refined in the United States from imported Mexican petroleum.
†There are discrepancies in the figures in the report.
‡Includes Maltha.

Rock Asphalts

Rock asphalts are limestones or sandstones impregnated with bitumen. Deposits are found widely distributed over the United States and Canada, the more important being located in Texas, Oklahoma and Kentucky. They are mined in a manner similar to that of ordinary rock quarrying. For use in road work the

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rock is crushed, and in order to secure the proper amount of asphalt or bitumen it may be necessary to mix two or more grades of the rock asphalt containing different percentages of bitumen. It is sometimes necessary to add more asphalt or to soften that already present by the addition of a suitable amount of flux.

Oil Asphalts

Oil asphalts are produced by distilling off the more volatile constituents of petroleum. Their characteristics can be made to vary, by the extent of their distillation, depending upon the use for which they are prepared. Those intended for use in asphalt macadam road construction are usually softer than those used for asphalt concrete or sheet asphalt pavements. In general a stiffer material is produced for use with the finer aggregates. The asphalts produced from petroleum are practically pure bitumen, while the native asphalts sometimes contain high percentages of mineral and organic impurities. The location of the oil fields from which oil asphalts are produced is given in the previous chapter on "Fluid Petroleum Products." The principal sources of asphalt are from the California and Mexican petroleums. Semi-asphaltic petroleums of Texas, Mid-continent and Southern Illinois oils usually necessitate blowing as well as distillation.

Native Asphalts

The principal native asphalts are Trinidad and Bermudez asphalts.

Trinidad asphalt comes from the island of that name. The main source is on La Brea Point, about 28 miles from Port of Spain, the chief town. Here there is a circular pitch lake of nearly 115 acres extent, between which and the sea are other pitch deposits more or less mixed with sand. The former furnishes the "lake asphalt" and the latter the "land asphalt" of the paving industry.

The material in the lake is described by Clifford Richardson as an emulsion of water, gas, bitumen, fine sand and clay. It is in constant motion owing to the evolution of gas, and for this reason, whenever a hole is dug in the surface, whether deep or shallow, it rapidly fills up and the surface resumes its original level after a short time. Although soft it can be readily flaked out with picks in large conchoidal masses weighing 50 to 75 pounds. It is honeycombed with gas cavities and resembles a Swiss cheese in structure. It is of uniform composition, as follows: Water and gas volatilized at 100°C., 29 per cent; bitumen soluble in cold carbon disulphide, 39 per cent; bitumen absorbed by mineral mat-

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ter, 0.3 per cent; mineral matter, 27.2 per cent; water of hydration in clay and silicates, 4.3 per cent.

Trinidad land asphalt reached the places where it is found either by overflowing from the lake or by intrusion into the soil from the same subterranean source that supplies the lake asphalt. Its character is much affected by the effect of the weathering to which it has been subjected. Clifford Richardson states that refined land asphalt of good quality differs from the lake supply by its higher specific gravity due to the larger amount of mineral matter it contains, by a higher softening or melting point, and a somewhat lower percentage of bitumen and, in consequence of these facts, a much greater hardness at all temperatures. Land asphalt requires much more paraffin flux than lake asphalt, and asphaltic oil fluxes offer certain advantages over paraffin fluxes for use with land asphalt.

Composition of Refined Trinidad and Bermudez Asphalts

(Clifford Richardson)

Bermudez asphalt comes from a pitch lake in Venezuela about 30 miles from the coast in an air line. The lake is about 1½ miles long, 1 mile wide, of irregular shape and covers about 900 acres. It is covered with a crust from a few inches to 2 feet thick, having some grass and shrubs, with a few palms, and the pitch is visible on the surface in but few places. It is very wet, so that excavations fill with water and it is difficult to excavate the pitch, which has an average depth of 4 feet. The deposit is probably formed by the exudation of a large quantity of soft maltha. The asphalt from the lake varies greatly in the amount of water it contains, which fluctuates between 11 and 46 per cent. This water is not emulsified with the bitumen but is adventitious surface water. The material for industrial use is selected, and when refined has the composition given in the accompanying table, which also gives the composition of refined Trinidad asphalt.

Meaning of Analysis.—The significance of most of the terms used in the table on page 314 are as follows:

Streak is the color of a rubbed or scratched surface.

Hardness is stated in terms of Mohr's scale, in which 1 is the hardness of talc, 2 that of rock salt, 3 that of calcite, 4 that of fluorite, etc. When a bitumen is softer than 1 on this scale its hardness is stated by its behavior in a penetration test, explained below.

Melting point is determined by an arbitrary test, because bituminous materials are made up of a mixture of hydrocarbons and their derivatives and can not have a true melting point, such as a definite compound possesses.

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	Trinidad	Bermudez
Specific gravity at 77°F. (25°C.)	1.40	1.08
Streak	Blue black	Black
Lustre	Dull	Bright
Structure	Homogeneous	Uniform
Fracture	Semi-conchoidal	Semi-conchoidal
Hardness	2	Soft
Melts	235°F. (113°C.)	183°F.(84°C.)
Penetration at 77°F. (25°C.)	4	20
Loss at 325°F. (163°C.), 7 hours	1.1%	3%
Character of residue	Smooth	Smooth
Loss at 400°F. (205°C.) 7 hours	4.0%	8.2%
Character of residue	Blistered	Wrinkled
Bitumen soluble in CS_2	56.5%	94.4%
Bitumen retained by mineral matter	0.3%	.....
Mineral matter	38.5%	3.6%
Water of hydration	4.2%	.....
Vegetable matter	.....	2.0%
Bitumen soluble in 88° naphtha	35.6%	62.2%
Percentage of total bitumen which above is	63.1%	65.4%
Soluble bitumen removed by H_2SO_4	61.3%	62.4%
Saturated hydrocarbons in total bitumen	24.4%	24.4%
Pure bitumen soluble in C Cl_4	100.0%	99.5%
Fixed carbon	10.8%	13.4%

Penetration is determined by the distance that a needle of specified size loaded with a specified weight will penetrate into a sample of the material at a specified temperature in a specified time. Usually a No. 2 sewing needle loaded so that the total weight is 100 grams and a time period of 5 seconds is employed, but a 50-gram weight and a 1-second time period are used with liquid bitumens. Prévost Hubbard makes the following statement regarding this test:

The penetration test is a convenient one to employ for identification and control, and is often indicative of the value of an oil or asphalt product for construction work. While the test for bituminous road materials is made in the same manner as in asphalt paving work, the standards for road purposes are somewhat different. No oil product should be employed in macadam construction with a penetration higher than 25 mm. when tested at 25°C. with a No. 2 needle for five seconds under a weight of 100 grams, unless it possesses the property of hardening considerably when subjected to the volatilization test. On the other hand, it is rarely necessary to require a penetration as high as that for asphaltic cement used in the topping of an asphalt pavement, for the reason that the upper course of a macadam road has much greater inherent stability than the sand course of the asphalt pavement. A penetration of from 10 to 15 mm. is usually considered sufficient for road work. If a material having a

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much lower penetration is selected, its susceptibility to temperature changes will have to be considered.

Pure bitumen soluble in CCl_4 (carbon tetrachloride) is not usually determined unless a road oil has been badly cracked or a solid bitumen like grahamite has been added, so that the percentage of hydrocarbons insoluble in 88° naphtha is high. The bitumens insoluble in carbon tetrachloride but soluble in carbon bisulphide are called "carbenes."

Maracaibo asphalt is found on the Limon River about 50 miles west of Maracaibo, Venezuela. According to Clifford Richardson it is an exudation from maltha springs. When carefully refined it contains from 92 to 97 per cent of bitumen soft enough to be indented by the finger nail. It contains a very small percentage of malthenes and has a higher softening point than either Trinidad or Bermudez asphalt.

Cuban asphalts are found in small quantities in many places on the island and what little use of them is made in the United States is mainly for varnishes. A deposit 18 miles from Havana has furnished material used in street pavements.

Asphaltic materials are found in many places in Mexico, and some of them have been developed more or less. What is usually known among roadbuilders as Mexican asphalt is prepared from the malthas and petroleums obtained mainly from the Tampico and Tuxpan district.

Natural asphalt has been obtained in California at several places, but the most noted deposits are no longer worked.

Refining natural asphalt consists merely in driving off the water it contains by heating the material to about 325°F. in large tanks containing coils of pipes through which steam is passed. In the bottom of the tanks are steam jets which agitate the asphalt. The vegetable impurities, if any, are skimmed from the top. The refined asphalt is drawn off while it is liquid into barrels for shipment. When it is to be used, it is melted with a residuum flux.

Gilsonite is a hard, brittle bitumen with a reddish brown streak and a conchoidal fracture, obtained mainly from Utah and Colorado. It is sold in two grades. gilsonite selects and gilsonite seconds, the former being the more pure. Gilsonite from different mines varies considerably, and some of it is of little value for use in paving mixtures.

Grahamite is a hard, brittle bitumen with a black streak, otherwise resembling gilsonite in appearance. Its softening point is very high and not yet definitely determined. It is obtained mainly from Oklahoma.

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Properties of Gilsonite and Grahamite

(Clifford Richardson, *The Modern Asphalt Pavement*)

	Gilsonite		Grahamite
Specific gravity, 78°/78°F.	1.044	1.049	1.171
Streak	Brown	Brown	Black
Lustre	Lustrous	Lustrous	Dull
Fracture	Sub-conchoidal	Sub-conchoidal	Hackly
Hardness	2	2	Brittle
Softens	260°F.	300°F.	Intumesces
Flows	275°F.	325°F.	Intumesces
Loss, 325°F., 7 hours	0.9%	2.3%	0.1%
Loss, 400°F., 7 hours	1.2%	4.0%	0.5%
Bitumen soluble in CS_2	99.0%	99.9%	94.1%
Insoluble organic matter	0.0%	0.0%	0.2%
Mineral matter	0.0%	0.1%	5.7%
Bitumen soluble 88° naphtha	47.2%	15.9%	0.4%
Soluble bitumen removed by H_2SO_4	87.7%	71.8%	25.0%
Total bitumen as saturated hydrocarbons	5.9%	4.5%	0.32%
Bitumen soluble in 62° naphtha	67.4%	30.3%	0.7%
Bitumen insoluble in CCl_4	0.0%	0.4%	68.7%
Fixed carbon	13.0%	13.4%	53.3%

Manajak resembles grahamite and is obtained from Barbadoes and South America. Its lack of uniformity and its high price have prevented any large use of it for American pavements, although it is used successfully in preparing other materials.

Fluxing Solid Bitumens.—Paving materials are made from solid bitumens by fluxing them with petroleum residuums by two methods. In the first method the residuum is heated to above the temperature at which the solid bitumen melts and the latter is then added. Grahamite does not melt but intumesces and the residuum to flux it must be raised to an exceptionally high temperature. The mixture is agitated until the bitumen is all melted and the combined material is of uniform quality.

In the second method, the residuum is heated to about 350°F. and air is then blown through it for 6 to 40 hours, depending upon the quality of the old and the properties desired in the finished product. As soon as it reaches the proper consistency the blowing is stopped and enough solid bitumen mixed with it to give a paving material having the required properties.

Probably the earliest use of asphalt materials for paving purposes in this country was in 1838, when a rock asphalt was imported from Europe. It was used in sidewalk construction in the

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portico of the old Merchants' Exchange Building at Philadelphia. In 1870 it was used in experimental paving opposite the City Hall, Newark, N. J. Asphalt from the island of Trinidad was used in 1879 in the City of Washington, D. C., in construction somewhat similar to our modern sheet asphalt type. From this time until the present the use of asphaltic materials for street surfaces has steadily increased in popularity until now they form the bulk of all the higher types of city pavements.

The asphaltic materials used in these pavements may vary widely in characteristics, depending upon the type of pavement for which they are intended. They may be very fluid if for a dust preventive or very stiff if intended for use in asphalt block or sheet asphalt construction.

The asphalt as it occurs in nature, either in petroleum, natural lakes or impregnating limestones and sandstones, usually requires some refining or working before it is suitable for use on the road. A few crude asphaltic petroleums meet the requirements for road oils and can be used without refining.

Since the character of the asphaltic materials vary widely, their selection should be carefully specified for any particular work. The following general specification for asphalt cement prepared by The Asphalt Association cover fully the requirements necessary for an asphaltic material which should produce a first-class pavement:

General Specification for Asphalt Cement for Use in the Construction of Asphalt Macadam, Asphaltic Concrete, Asphalt Block and Sheet Asphalt Pavements.

Physical and Chemical Properties.

General.—The asphalt cement shall be homogeneous, free from water and shall not foam when heated to 175°C. It shall meet the following requirements:

1.	Specific gravity 25°/25°C., not less than	1.000
2.	Flash point, not less than	175°C
3.	Penetration at 25°C. 100g., 5 sec.	*—to—*
4.	Ductility at 25°C., not less than	30**
5.	Loss at 163°C., 5 hours, not more than	3%
	a. Penetration of residue at 25°C., 100g., 5 sec. as per cent of original penetration, not less than	50.%
6.	Per cent of total bitumen soluble in carbon tetrachloride, not less than	99.%

*NOTE.—The exact penetration limits should be inserted by the engineer to meet the particular requirements of the type of pavement, and climatic and traffic conditions for which the asphalt cement is to be used. It is recommended that a 10 point limit be allowed for asphalt cement of less than 90 penetration and that a 30 point limit be allowed for asphalt cement of over 90 penetration. The following table of limits may be of service to the engineer as suggesting suitable penetrations for various conditions.

**NOTE.—For asphalt block the ductility at 25°C. shall be from 5 to 8.

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Type of Pavement	Traffic	Temperatures		
		Low	Moderate	High
Asphalt macadam	Light	120–150	90–120	80–90
	Moderate	90–120	90–120	80–90
	Heavy	80–90	80–90	80–90
Asphaltic concrete (coarse graded)	Light	70–80	70–80	60–70
	Moderate	70–80	70–80	60–70
	Heavy	60–70	60–70	60–70
Asphaltic concrete (fine graded)	Light	60–70	60–70	50–60
	Moderate	60–70	60–70	50–60
	Heavy	50–60	50–60	50–60
Sheet asphalt	Light	50–60	50–60	40–50
	Moderate	50–60	50–60	40–50
	Heavy	40–50	40–50	30–40
Asphalt block	Light	15–25	15–25	10–15
	Moderate	15–25	15–20	10–15
	Heavy	15–20	10–15	5–15

Sample.—A 1-pound sample of the asphalt cement that the contractor proposes to use in his work, together with a statement as to its source and character, must be handed in with his bid. If the contractor proposes to prepare the asphalt cement at the paving plant, then in lieu of the above a 1-pound sample each of liquid flux and refined asphalt must be handed in with his bid, together with a statement as to the source and character of each and the proportions in which they will be combined to produce the asphalt cement which he proposes to use. No asphalt cement, flux or refined asphalt other than that specified in his bid shall be used by any contractor except with the written consent of the engineer and provided that the asphalt cement used shall comply in all respects with the requirements of these specifications.

Methods of Testing.—Tests of the physical and chemical characteristics of the asphalt cement shall be made in accordance with the following methods:

1. Specific Gravity, U. S. Dept. of Agriculture Bulletin 314, P. 5.
2. Flash Point (open cup), U. S. Dept. of Agriculture Bulletin 314, P. 17.
3. Penetration, A. S. T. M. Standard Test D–5–16.
4. Ductility, Proc. A. S. T. M. Vol. 9, P. 594.
5. Volatilization Test, U. S. Dept. of Agriculture Bulletin 314, P. 19, using 50-gram sample.
6. Bitumen insoluble in carbon tetrachloride, U. S. Dept. of Agriculture Bulletin 314, P. 29.

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Handling Road Oil

Shipping.—Small quantities of road oil are shipped in tight wooden 50-gallon barrels, such as are used for shipping molasses, or in steel barrels. These barrels make the oil cost 2 to 3 cents a gallon more than the price for the oil itself. Uninjured empty barrels can generally be resold to the shipper. Heavy oil is troublesome to remove from barrels, and they are usually dumped into the open heating kettles and broken up. When the oil is warm the broken pieces of wood are raked out and used for fuel. If there is no heating kettle on the job, the barrels of heavy oil must be kept close to a fire or in a very warm room before the oil can be poured from them into the distributor.

Large quantities of oil are shipped in tank cars, holding 8,000 to 12,000 gallons. Where a large amount of oil is to be used annually near any railway, it will be desirable for the officials to supply a tank into which the oil can be run as soon as the car arrives.

If oil must be used hot, a ¾ or 1-inch steam connection must be made with the heating coils of the tank car. For this reason, the car is often spotted on a siding near an electric station or mill, but the steam can also be furnished by a road roller, traction engine or other convenient source. It will take from twelve to twenty-four hours to heat a tankful of heavy oil to 150° to 170°F., which is high enough to allow it to be pumped. The temperature can be increased after that in the distributor. The amount of steam supplied to the heating coils of the car is regulated by a valve on the exhaust pipe of the coil, which is adjusted to prevent a waste of steam. As some road oils have a low flash point, great care must be taken to prevent any oil coming in contact with a flame. The temperature of the oil should be tested from time to time with a thermometer, to see that it is not overheated. If there is any water in the oil it will give a great deal of trouble if heated quickly, and if foaming is detected the rate of heating should be checked at once.

Pumping.—In order to remove the oil from the tank car to the distributors, some form of pump is generally necessary, for it is not often that the car can be placed on a siding or trestle high enough to allow it to be emptied by gravity.

If a lift pump set in the top of the car is used, it should be a 3 or 4-inch size. With it one man can fill a 600-gallon distributor in twenty minutes.

In many cases a hose or pipe is connected to the bottom of the car and run to an oil pump, operated by a steam or gasoline engine, which forces the oil into the distributor. A 1½ or 2-inch

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power-driven rotary pump will deliver 600 gallons in ten to fifteen minutes. These pumps work with either hot or cold oil. A water tank pump can be used with cold oil, but hot oil will ruin the valves speedily. A 2-inch suction tank pump will fill a 600-gallon tank in thirty to forty minutes.

The hose used in the connections between the pump and the bottom of the tank car should be as short as possible, because the oil often destroys it rapidly. It is desirable to have a cut-off valve in the connection pipe. When everything is coupled ready for use, the discharge valve in the bottom of the car is raised by means of a vertical stem running up to the dome of the car, and the flow of oil is controlled by the cut-off valve, for the manipulation of the tank valve is quite troublesome.

As the fixed and operating charges at an oil storage plant are about the same irrespective of the amount of oil delivered into distributors, it is desirable to load as many carts daily as practicable, in order to reduce the unit cost of such work. In California, where large amounts of oil are used in surfacing concrete roads, oil stations have been designed with particular attention to effecting such economics. It is considered desirable to have the oil at a temperature of 300°F. when it is applied, so it is heated to 325° for delivery within 10 miles and 350° for longer deliveries.

The oil is discharged from the cars into storage tanks or pits holding 10,000 to 25,000 gallons. These contain steam coils to warm the oil sufficiently to enable it to be pumped into a circulating tank holding 2,000 to 3,000 gallons, where it is heated further by steam coils. The oil is then pumped through a heater and back into the circulating tank until its temperature is about 200°, after which the temperature of the heater is raised and the oil pumped through it into the distributor. The whole operation takes one and one-half hours.

The heater resembles a return tubular boiler. The furnace has a fire brick arch and walls and is heated by oil burners. The heated gases pass over the furnace arch in a chamber formed of ordinary brick masonry, and finally escape through a steel stack. The oil is pumped through a multiple grid of 3-inch pipes. The design is made on the assumption that with furnace temperatures of 1,800 to 2,000°, 1 square foot of heating surface will transmit 3 British thermal units per hour per degree of change in temperature.

Purchasing Oil.—Oil increases in volume from 0.3 to 0.4 per cent for each 10°F. rise in its temperature. The oil is bought on the basis of its volume at 60°F., and if measured at any other temperature its volume must be computed, or, in the case of an

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Volume of Oil at 60°F. Equivalent to Unit Volume at Stated Temperatures in Fahrenheit Degrees

0°F	0	10	20	30	40	50	60	70	80	90
.....	.....	.....	.....	.....	.....	.....	1.000	0.996	0.992	0.988
100	0.984	0.980	0.977	0.973	0.969	0.965	0.962	0.958	0.954	0.951
200	0.947	0.943	0.940	0.936	0.933	0.929	0.926	0.922	0.919	0.916
300	0.912	0.909	0.906	0.903	0.899	0.896	0.893	0.890	0.886	0.883
400	0.881	0.877	0.875	0.871	0.868	0.865	0.862	0.859	0.856	0.853

NOTE.—This table is based on the assumption that the volume of oil increases 0.4 per cent for every increase of 10°F. above 60°. This rule is exactly applicable only to some oils. In Los Angeles County, Cal., the rate of increase in volume is taken at 0.3 per cent in the specifications of the county road department.

oil having an increase in volume of 0.4 per cent per 10°F., the accompanying table will give the volume at 60° with a minimum amount of figuring. To use it, multiply the tabular number for the temperature at which the measurement was made by the measured quantity of oil. For example, 1,100 gallons of oil at 375°F. multiplied by 0.888 gives 978 gallons as the volume at 60°F. If the rate of increase per 10°F. was 0.3 per cent, the volume at 60°F. would be 995 gallons.

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Chemists & Chemical Engineers
Asphalt, Road Materials, Water, Coal
General Chemical Analyses and Reports
227 Front Street, New York City

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TAR AND TAR PRODUCTS

By PHILIP P. SHARPLES

The tar materials originally used in road work were obtained from the tar produced in city gas works. Today the tar produced in coke ovens in connection with steel plants and other industrial operations has become the largest source of raw material for road tars and promises to be of even more importance in the future. In addition to these coal tars a certain amount of water gas or oil tar is used for the manufacture of road tars.

The process of producing coal tar is in principle the same whether produced in the gas house or the coke-oven plant. The difference so far as the tar is concerned is mainly in the size of the retorts used. In either case the retorts are built of fire clays, but in the gas house hold 400 to 600 pounds while in the coke oven hold 12,000 pounds or more. The retorts are filled with bituminous coal and subjected to extreme heat. The coal is broken down chemically and from the retort illuminating gas is given off mixed with ammonia vapors and tar vapors.

The ammonia and tar are extracted from the stream of gas by condensation and the tar is the raw material from which road tars are manufactured.

Water gas or oil tar is produced in the enrichment of water gas. Water gas is produced by allowing steam to pass through a bed of red-hot coke. The resulting gas, a mixture of carbon monoxide and hydrogen, has no illuminating value, but by passing certain petroleum oils through a bed of hot coke they are broken down, giving gases rich in carbon which, when mixed with the water gas, give it illuminating value. The purification of these gases yields a tar resembling in some respects the coal tars. It is distinguished by a characteristic odor and freedom from ammoniacal vapors and usually the absence of tar acids, although these may be present in small amount.

The characteristics of the various tars are shown in the accompanying table. It will be seen that they differ much in physical constants and it is the province of the manufacturer to produce uniform products from these diverse raw materials.

In order to meet any given specification it is usually necessary to carefully blend the tars in order that the physical constants may be properly balanced. The process of manufacture beyond the blending is one of simple distillation. The tar is put in large cylindrical boilers and carefully heated to drive off the water, if this has not already been removed in a separate dehydrating

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process. Light oils, the source of benzol and toluol, are given off first and then carbolic oils. If the distillation is carried further, creosote oils used in wood blocks and other timber preservation, and finally anthracene, are obtained.

The material left in the still is the source of the road tars and the viscosity desired determines the point at which the distillation is stopped. For a light tar for surface treatments, the water alone is removed; for binders, the light oil and some of the carbolic oil, while for paving pitch the distillation is carried through the creosote oils.

Road tars made by distilling to the required viscosity are called "straight run." If the distillation is carried beyond the point desired and the resulting pitch brought back to the desired consistency by thinning with a proper tar oil, the product is called a "cut back." The latter method is used in England and the continent, where certain fractions of oil are desired, but is not practiced to any extent in the United States.

An examination of the accompanying table will show the characteristics of pitches made from different tars and the importance of proper blending and choice of tars to produce a uniform material.

Specifications for road tars usually call for the following constants: Specific gravity, melting point or viscosity, free carbon, distillation, specific gravity of the distillate, and melting point of the residue. The usually accepted constants are given in the accompanying table. In writing specifications, great care must be observed to coordinate the different parts of the specification. A change in the viscosity requires a change in the specific gravity, free carbon and distillation requirement. The different parts of the specification are interlocking.

The methods used in testing must also be given in great detail, as slight variations in the method used for testing give very radical differences in the figures obtained. Happily many of the tests have been standardized by the A. S. T. M., and in the melting point, free carbon and distillation tests, a simple reference to the A. S. T. M. method is all that is necessary.

The valuation of a road tar rests ultimately on its successful use on the roads, and the specifications are based on the analysis of materials that have given good results. Much, however, still depends on successful manufacturing methods and choice of tars that are known to give reliable results.

The different tests are interpreted as follows:

Specific Gravity.—The specific gravity is an indication of the kind of tar used. As will be seen by consulting the table of tars of different origins, the specific gravity varies widely. As, how-

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ever, the specific gravity is modified in manufacture, the kind of road tar examined must be taken into account in considering the specific gravity.

Viscosity. Float Test, Melting Point.—The viscosity is a measure of the fluidity of the tar; is determined in the thin tars for cold-surface applications at 40° C. (104° F.) and for tars for hot-surface applications at 100° C. (212° F.). The determination of the viscosity is a very important test, as it not only shows the class to which the tar belongs but tells how the tar will act in the mechanical spraying devices used for its application on the road. As the fluidity of a tar is dependent on the temperature, the temperature of application must be considered in making up the specifications.

The melting point is used with binders. Usually a higher melting point is designated in the South. The float test is another form of melting-point test, but is expressed in seconds like viscosity. It may be used on tars for hot-surface treatment as well as for binders.

Free Carbon.—The province of free carbon in road tars has been the subject of considerable controversy. From a theoretical standpoint (see Hubbard—Dust Preventives and Road Binders) free carbon is an inert substance which has no value in a road tar. From a practical standpoint, the presence of free carbon gives a certain stability to the tar and makes it less susceptible to atmospheric changes. For this reason a higher content is desirable in the road binders and block pavement fillers than in tars used for hot-surface treatment. In tars used for cold-surface treatment, where the problem is one of direct penetration into the road surface, a low carbon content is desirable. These considerations are taken into account in the accepted applications for coal-tar (high carbon tar) specifications.

Distillation.—The distillation is important in determining whether the material has been properly manufactured. An examination of the results shows the presence of water, and in connection with the specific gravity of the distillate and the melting point of the residue shows whether water-gas tar was used in manufacture and indicates whether it is a straight run or a cut-back material.

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Specifications of Several State Highway Departments for Tar Products for Different Classes of Road Work

	TARS FOR COLD SURFACE APPLICATION						TARS FOR HOT SURFACE APPLICATION					
	HIGH CARBON			LOW CARBON			HIGH CARBON			LOW CARBON		
	New York	Ohio	Office of Public Roads	New York	Ohio	Office of Public Roads	New York	Ohio	Office of Public Roads	New York	Ohio	Office of Public Roads
Specific gravity	1.14 to 1.18	.....	Not less than 1.10	1.10 to 1.13	1.10 to 1.16	1.10 to 1.14	Not less than 1.19	1.18 to 1.25	Notlessthan 1.13	Notlessthan 1.14	Notlessthan 1.14	.....
At degrees C	25°	.....	25°	25°	25°	25°	25°	25°	.....	25°	.....	.....
Float test, seconds	.....	.....	.....	.....	.....	.....	75 to 95	120 to 180	60 to 150	70 to 90	120 to 180	.....
At degrees C	.....	.....	.....	.....	.....	.....	50	32	32°	50	32	.....
Viscosity in seconds	225–350*	.....	8-13t	225 to 350*	10 to 20t	25 to 35t	.....	.....	.....	.....	.....	.....
Free carbon per cent	4% to 12%	.....	Not over 10%	0% to 2%	4 to 12%	0 to 5%	10% to 22%	.....	0 to 15%	0% to 4%	.....	.....
Distillation per cent to 170° C maximum	5%	.....	5%	5%	5%	2%	0	1%	1%	1%	1%	.....
170°–235° C maximum	18%	.....	.....	20%	.....	.....	10%	.....	.....	12%	.....	.....
235°–270° C maximum	25%	.....	30%	28%	.....	25%	16%	16%	15%	20%	20%	.....
270°–300° C maximum	32%	.....	40%	35%	30%	35%	20%	24%	25%	25%	25%	.....
Specific gravity of distillate at 250° C	1.01 at 25°	.....	.....	.....	.....	.....	Not less than 1.03	1.03	.....	.....	1.00	.....
Melting point of residue degrees C	.....	.....	.....	.....	65°	.....	.....	70°	.....	.....	70°	.....
Melting point of residue ball and ring, degrees C.	70°	.....	.....	70°	.....	.....	75°	.....	.....	75°	.....	.....

*At 40° C for 100 cc. t Specific viscosity at 40°. †Melting point, ball and ring.

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	TARS FOR CONSTRUCTION					
	HIGH CARBON			LOW CARBON		
	New York	Ohio	Office of Public Roads	New York	Ohio	Office of Public Roads
Specific gravity	Not less than 1.20	1.20 to 1.27	1.20 to 1.25	Not less than 1.16	1.16 to 1.20	1.15 to 1.20
At degrees C	25°	25°	25°	25°	.....	25°
Float tests, seconds	.....	120 to 180	120 to 150	.....	150 to 210	120 to 150
At degrees C	.....	50	50	.....	50	50
Viscosity in seconds	27 to 34†	.....	.....	27 to 34†	.....	.....
Free carbon per cent	12% to 25%	10% to 22%	3% to 20%	0 to 5%	0 to 10%	0 to 3%
Distillation per cent to 170° C maximum	0	0	1	0	0	1%
170°–235° C maximum	3	.....	.....	5%	.....	.....
235°–270° C maximum	12	10	10%	15%	10%	10%
270°–300° C maximum	16	20	20%	20%	20%	20%
Special gravity of distillate at 250° C	1.03	1.03	.....	.....	1.00	.....
Melting point of residue degrees C	.....	70°	65°	.....	70°	65
Melting point of residue ball and ring, degrees C	75°	.....	.....	75°	.....	.....

*At 40° C. for 100 cc. t Specific viscosity at 40°. †Melting point, ball and ring.

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Characteristics of Crude Tars and Their Residual Pitches

(From Philip P. Sharples)

	Horizontal Gas, 16th Street New York		Horizontal Gas, Astoria, N. Y.		Inclined Gas, Astoria, N. Y.		Coke Oven,[2] Lebanon, Pa.		Vertical Gas, Providence, R. I.		Water Gas, Ravenswood	
	Tar	Pitch	Tar	Pitch	Tar	Pitch	Tar	Pitch	Tar	Pitch	Tar	Pitch
Specific gravity, 15.5°C	1.293	1.357	1.267	1.306	1.238	1.284	1.187	1.281	1.153	1.225	1.074	1.190
Free carbon, per cent	37.5	46.1	28.9	33.5	24.3	30.4	10.8	19.3	4.0	10.4	0.3	1.1
Viscosity, Engler, 100°C	30.0	.....	21.8	.....	14.9	.....	3.0	.....	2.1	.....	1.6	.....
Melting point, degrees F	.....	127	.....	131	.....	130	.....	133	.....	145	.....	139
Oil[1] per cent	.....	.....	13.2	.....	14.3	.....	21.8	.....	28.8	.....	45.1	.....
Fixed carbon, per cent	.....	51.5	.....	42.0	.....	37.9	.....	28.8	.....	19.1	.....	23.8
Tar acids in oil, per cent	.....	.....	14.0	.....	21.0	.....	4.0	.....	29.0	.....	0.0	.....
Ash, per cent	.....	0.4	.....	0.21	.....	0.10	.....	0.48	.....	0.23	.....	0.06

[1]Amount of oil produced when the tars are distilled to a soft pitch.

[2]Semet-Solvay ovens. Concerning this type Prevost Hubbard makes the following comment: "The low percentage of free carbon is characteristic of the Semet-Solvay coke oven tars, which usually carry from 3 to 10 per cent of this constituent. The Otto-Hoffman ovens produce higher carbon tars as they are fired at a higher temperature."

NOTE.—"It will be noted that there is a great difference in specific gravity, the specific viscosity, and the percentage of free carbon, and that these vary in somewhat the same way. While this accord in the variations is marked in the type of samples taken, it is not universally true, and we may have samples in which the variations would not fall in the same place in the different columns, although there are no very marked diversities. The amount of oils produced when the tars are distilled to a soft pitch varies inversely. This is also subject to individual variations, although the general quantities yielded vary as indicated. In the tar acids produced, however, it will be noted that the different tars show no gradual variation. The one marked feature of this line is the absence of tar acids in the water-gas tar oil; but even here samples may be found which have small percentages of acid. It is also possible to obtain cokeoven tars which contain a large percentage of tar acid."—Philip P. Sharples.

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Specifications of Several State Highway Departments for Tar Products for Different Classes of Road Work

	New Jersey				New York					
	Coal Tar		Water Gas Tar		High Carbon			Low Carbon		
	N	M	UA	U2	Binder	H. O.	C. O.	Binder	H. O.	C. O.
Specific gravity	1.12–1.18	1.22–1.30	1.09–1.12	1.14–1.17	1.2+	1.19+	1.14–1.18	1.16+	1.14+	1.10–1.13
at degrees C	15.5	15.5	25	25	25	25	25	25	25	25
Float test, seconds	.....	120–150	.....	16–20	.....	18–28	.....	.....	15–25	.....
at degrees C	.....	50	.....	100	.....	.....	.....	.....	100	.....
Viscosity	150–300[1]	.....	60–100	.....	.....	.....	125[2]	.....	.....	125[2]
Free carbon, per cent	4–12	15–25	3	3	12–25	10–22	4–12	5	4	2
Distillation, per cent	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
to 170°C., maximum	7	0.1	3	1	0	0	5	0	1	5
170°-235°C., maximum	.....	.....	20	5	3	10	18	5	12	20
235°-270°C., maximum	35	15	37	15	12	16	25	15	20	28
270°-300°C., maximum	.....	.....	50	30	16	20	32	20	25	25
Specific gravity of distillate at 15.5°C	1.01	1.03	.....	.....	1.03[2]	1.03[2]	1.01[2]	.....	.....	.....
Melting point of residue, degrees C	75	75	60	65	75	75	70	75	75	70
Melting point, ball and ring, degrees C	.....	.....	.....	.....	27	.....	.....	27–34	.....	.....

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BITUMINOUS SURFACE APPLICATIONS[1]

Surface applications vary widely in character, according to their purpose. In most cases such an application is essentially a maintenance measure, but in the case of the bituminous mats or wearing courses used in California, or the mats now laid on new water-bound macadam, the first cost of such work is essentially a part of the first cost of the improvement. The practice in making such surface applications of any general type varies widely in different parts of the country, more widely than the practice in any other branch of road work. Whether greater uniformity will prove desirable or the work can be done successfully by a wide variety of methods can not be definitely determined until the records of such work and of the traffic on roads are kept with more detail and uniformity than at present. The widespread interest in the subject is one of the leading characteristics of highway affairs, and is an evidence of the conditions mentioned.

Oiling Earth Roads

Surface applications on earth roads were made in California many years ago, and a method of incorporating oil and earth by a special form of roller was employed for some time. More recently well-built earth roads in Iowa and Illinois have received surface applications as a maintenance measure. The experience in these states shows that while some success follows applications on roads that are not in good condition, it is very desirable to have the surface properly shaped and hard before the oil is applied. The oil binds the grains of earth together and reduces the dust, but it does not give the resistance to attrition which a hard surface affords. The treatment is therefore one which must be regarded as adapted only for roads with light traffic and light vehicles. If sand instead of earth is present, the methods of construction first used in Massachusetts and described on page 345 should be considered.

If the road has ruts and holes in the surface and is poorly drained, water will collect in puddles, soften the oiled crust at these places, and seep into the roadbed. The material under the crust will give way under heavy loads and the money spent in oiling will be largely lost, because the oiled material will become mixed with the unoiled material below and dust will be produced about as freely as on an unoiled road. Furthermore, the oiling of a mudhole often aggravates troubles due to such a defect.

[1] Revised but not rewritten by The Asphalt Association.

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The surface to receive the application must be moderately dry and warm, or the oil will not penetrate the pores, and it must be free from dust, for the oil forms flakes or scales with the dust and these are a worse nuisance than plain dust, being very irritating to the eyes.

Both cold and hot applications have been used successfully in Iowa, but the State Highway Commission prefers to heat the oil, as it apparently gives enough better penetration to justify the additional expense. It is desirable to secure the advice of a specialist in selecting the oil. A light oil must be used and as it may have a low flash point, care should be taken to keep it at a temperature below its flash point and to prevent any of it coming into contact with a flame. No matter what product is used, it should be applied with a mechanical distributor, designed for the purpose and capable of spreading it uniformly over the surface, preferably under pressure and atomized. The first application is made at a rate of about ½ gallon per square yard, and later applications at the rate of ¼ to 1/3 gallon. The brief experience in such work indicates that two light applications annually for two years, and afterward a single application annually, will be sufficient on a road adapted for such treatment and not subject to traffic requiring a more durable surface. During 1916 the Illinois State highway department issued the following advice on the work:

> The best results may be secured during the first application, by applying either a cold oil or at least a very thin product that will penetrate the surface of the road several inches and at the same time contain as many binding elements as possible so as to seal all pores in the earth, making it waterproof and at the same time adding some binding qualities that may assist the bond of the soil itself. A suitable product, as is commonly expressed, may vary from 30 to 60 per cent in asphalt. After the surface of the road has been thoroughly saturated, a hot oil or a slightly heavier product may be used.
>
> If the heavier oils are used for the first application they will not readily penetrate the surface of the road and will consequently form a mat on top. The forming of the mat before the surface of the road is more or less waterproof may be a serious fault, as moisture will accumulate beneath the mat and the road will be much slower in drying out than it would had the oil not been applied. The mat surface with a soft subsoil will rut more readily, besides breaking and scaling off in large pieces, making the road surface rough and undesirable.

The Illinois authorities recommend covering the oiled surface with clean, hard, coarse sand, at the rate of a cubic yard to 100 to 150 square yards.

Broken Stone Road Surfacing

It has been found that a surface application on a new waterbound macadam road may prove unsatisfactory, although if the

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road is exposed to traffic for three months the desired results are obtained if the treatment is properly carried out. This is probably due to the large amount of fine, lightly bound dust on the roadway, which is removed by the early traffic, or to the greater stability of the road as a result of its consolidation by traffic. In New York, macadam roads finished so late in the fall that they can not have three months' wear before winter, are sometimes given a surface application of calcium chloride as a temporary protection against raveling during the months that must elapse before bituminous surfacing can be placed.

In making thin surface applications to an old road that is thick enough to carry the prospective traffic and has a surface in fair condition, the ruts and holes must first be patched. This is best done several days in advance of the surfacing. It is desirable to cut the edges of a hole so as to secure vertical faces to which the new material will adhere properly; a patch with a feather edge is liable to push ahead by traffic and prove unsatisfactory. Each hole or rut is swept clean, painted with bituminous material and filled with ¾ to 1½-inch stone and binder and thoroughly tamped into place. The stone and binder are often mixed at a central point and carted along the road by the patching gang, for use where required. Just before the surfacing is done, the road is swept thoroughly, often with some type of revolving broom. Sometimes wire brooms are used first and then fiber brooms. The oil is applied hot or cold, according to quality, at the rate of about 0.2 to 0.5 gallon per square yard, as the engineer considers best, and then covered with clean screenings, granulated slag or pea gravel at the rate of from 25 to 60 pounds per square yard. The oil is applied by hand on small work, but usually with a distributor. If the screenings are distributed by hand they should be previously deposited in piles at convenient intervals along the roadside. They are, however, sometimes distributed by spreader carts. The road may then be opened to traffic almost immediately after application of the mineral cover.

If the road oil rises through the screenings, or "bleeds," in hot weather, more screenings should be spread over those places. If the road is used mainly by automobiles, a thin covering of screenings is sometimes spread first and later a covering of sand or other fine material, to act as a filler and prevent the tires from dislodging the screenings.

The following rules for the amount of bituminous material to be used in surfacing broken stone roads were prepared by George H. Biles, second deputy highway commissioner of Pennsylvania:

If the surface of the road is made up of pieces of ballast-size stone (3-inch) from which traffic has removed all the fine material, leaving large surface voids between the stone, enough of the bituminous material must

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be applied so that it will flush up level to the top of the large pieces of stone and firmly bind the chips and gravel which lie in the crevices between the stone.

If, on the other hand, the surface of the road is equally clean, but traffic has not removed the fine particles between these stones to the same extent, and the crevices between them are consequently smaller, then a somewhat smaller amount of bituminous material should be used, since an excess will again flow off the road.

In treating a road which has recently been resurfaced, it will be found often that even after all the screenings and fine material have been swept from the top of the road, leaving the large stones bare, there will still be a certain amount of dust and fine material between the stones which has not yet been compacted thoroughly by traffic and which will absorb the bituminous material like a blotter, leaving only a brown stain in these spaces. In such cases, the amount of application must be increased until this fine material is well saturated and there is enough of the bituminous material near the surface of the road to bind thoroughly the covering of chips or gravel.

On the Illinois highways, when a double application is made, about ¼ gallon per square yard is used on each application, and the preferred covering is torpedo sand, ⅛ to ⅜ inch in size, but clean stone chips are also employed. The total amount of covering material with such a treatment is one cubic yard for each 125 square yards of road. When a single application is made 1/3 to ½ gallon of oil per square yard and a cubic yard of torpedo sand for every 150 square yards of road are employed.

Bituminous sandstone obtained in Kentucky has been used in parts of that state for re-surfacing old macadam. The latter is scarified, smoothed with a road machine, and enough new stone added to give the desired thickness and contour. This is rolled thoroughly and then covered with pulverized bituminous sandstone to a depth of about 1¾ inches, loose, when spread. It is desirable to allow the sun to shine on the loose material for a few hours, until it appears slightly oily, and then roll it, slowly at first and later more rapidly.

Concrete Road Surfacing

Surface applications to concrete roads have been employed in a number of States with more or less success. They have been used to the greatest extent in California, where both a thin wearing surface and an asphaltic mixture are used. The following information concerning both types was supplied by Austin D. Fletcher, State highway engineer of California:

The thin bituminous wearing surface is about half an inch in thickness when completed. After it has been under traffic for a few months it is found to contain a fairly uniform mixture of mineral aggregate and bituminous binder consisting of about 8 to 11 per cent of bitumen and the balance mineral aggregate of a fairly uniform grading running from dust to rock of ½-inch maximum diameter. It shows no tendency to flow or

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creep and the surface remains true and free from rolling. The concrete base, however, must be finished with a true, smooth surface to make a good riding highway, as this type of surfacing is not thick enough to smooth up to any considerable extent a concrete pavement whose surface is uneven.

The procedure in laying this thin wearing surface is as follows: First the surface of concrete is cleaned of dirt, dust films and any thin coat of laitance. This is best accomplished by opening the bare concrete to traffic for a month or two. The iron-shod traffic and the rapidly moving rubber tires are of greatest help in breaking any weak layers or dirt or laitance and exposing the surface of the concrete proper. This "traffic cleaning" is followed by brushing with revolving street brooms and hand brooms. In some cases flushing the surface with water is a help in washing off any thin coat of clay. It is of greatest importance that the asphaltic oil bind to the solid concrete and not to any overlying weak film of dirt. The care taken in getting a clean concrete is without doubt in a large measure responsible for the success of this surfacing because of the strength of the bond between the concrete and the bituminous wearing coat. The few failures where the wearing surface has been stripped from the concrete have been nearly always easy to trace to a pavement improperly cleaned prior to the application of the road oil.

After the concrete has been cleaned the asphaltic oil is applied by a pressure distributor at the rate of ¼ gallon per square yard. This oil surface is immediately covered by a layer of either crushed rock screenings or fine gravel of ⅛ to ½ inch. This material may contain some fines and dust, but should be fairly clean.

The screenings are applied by shoveling from piles placed at frequent intervals alongside the road. The shovelers can be taught to so throw the screenings that they will cover the road surface with a fairly uniform thickness. The road can now with advantage be given a light rolling, but this is not necessary. Any excess screenings should be swept into piles alongside of the road to be used on the second application of road oil. This is applied on the second application at the same rate and is covered with screenings as before.

The road is now thrown open to traffic and during the first two weeks may require further screenings to take up excess oil. The traffic is of great assistance in forcing the screenings into the oil and compacting and making a homogeneous carpet on the concrete.

The oil is applied to the road at a temperature of from 250° to 300°. It contains approximately 90 per cent of 80° penetration asphalt. In California the road oil companies classify this product as a "90-80" road oil.

In building the thin bituminous wearing surface for concrete pavements two physical properties of the road oil are of greatest importance. First the oil must be of such a viscosity that when applied to the road it will readily combine with the screenings that are thrown upon its surface. A very viscous oil will form a hard surface and the screenings will lie there without being absorbed and to a large extent be thrown off the road by the passing traffic. Only a small amount will settle or be forced into the oil and the surface will not build up into a satisfactory protecting wearing coat.

The second physical property of great importance is that the road oil must be cementing or adhesive, so that it will bind tightly to the concrete surface and bind together all of the fragments of stone screenings. It should be an active cement and if it is not sticky then the wearing surface

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will not be firm enough to resist the push and pull of the passing traffic. The State highway routes leading from the great centers of population have required a higher type of surfacing to meet successfully the demands of heavy traffic.

After proper curing of the concrete its surface is cleaned of all dirt and dust films and given a paint binder coat composed of asphaltic cement and engine distillate of lightest gravity. The asphalt used has a penetration between 80° and 90°, the mix being one part asphalt and one to two parts distillate, the exact proportion of distillate being determined by trial. The satisfactory mixture is one that paints the concrete with a thin, uniform, glossy black film which becomes hard two hours after application.

The surfacing used has the following composition expressed in percentages:

Bitumen soluble in carbon disulphide, 7½-10 per cent.

Aggregate:

PASSING	REFUSING	
200 sieve	.....	8–13 per cent.
80 "	200 sieve	14–25 "
40 "	80 "	17–29 "
10 "	40 "	5–11 "
4 "	10 "	15–25 "
2 "	4 "	3–10 "
2 "	.....	100 "

The asphaltic cement used has a penetration of from 70 to 90 degrees, District of Columbia standard, and passes the usual requirements for solubility, volatility and ductility. The heating of asphalt, aggregates and dust and mixing and laying follow the usual practice.

Prior to the laying of the surfacing, the testing laboratory makes grading tests of such sand, limestone dust and rock screenings as will be available for the work and selects such of these that give the desired mix. In this selection the following points are considered important:

Let a be taken as the percentage of asphaltic cement that will be used in the finished material. Then the dust passing the 200-mesh sieve should at least equal a–1. The fine sand passing the 80 mesh and retained on the 200 should be approximately $2a$. If the available sand is high on the finer sieves a may be taken as high as 9.5 per cent. If the sand is coarse, a may be as low as 8 per cent for the trial mix. The coarse aggregate passing the No. 2 sieve and retained on No. 10 should be from 28 to 35 per cent of the other mix. If these points are satisfied by the available material the weights of coarse aggregate, fine aggregate, dust and asphaltic cement can be given to the road crew for a trial batch. Under field working conditions a trial batch will show if the mix is "wet" or "dry" and by a slight change in the percentage of asphaltic cement a mixture can be made that will rake and roll properly. In this way the mineral aggregate is not changed but kept under known satisfactory grading. As the work proceeds, grading tests should be run at frequent intervals on the different mineral aggregates to insure a uniform grading in the finished pavement. Analysis of samples of the different batches should also be made to check the uniformity of the mix.

The surface after thorough rolling should have a specific gravity in excess of 2.20 if the sands and crushed rock screenings are of average specific gravities. A sample of the finished pavement taken each day and tested for specific gravity will indicate if there has been insufficient compression, either due to method of rolling or to the surface being too cold when rolled.

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BITUMINOUS ROADS [1]

Bituminous materials are used on gravel and broken stone roads in three ways: (1) thoroughly mixed with the stone or gravel before the latter is placed on the roads; (2) driven into the interstices between the stone after the latter has been placed on the road; (3) applied to the surface of a finished gravel or broken stone road. The first method produces what is now commonly called bituminous concrete or mixing method and the second method bituminous macadam or penetration method. These will be described in this section and surface applications will be described in the next section.

Rocks for Bituminous Roads[2]

In bituminous road work observations indicate that in some cases it is advantageous to use a rock of relatively high absorption rather than one with low absorptive qualities, owing to a better adhesion of the bituminous material by a partial surface impregnation of the rock.

While the binding or cementing value of a rock is a most important consideration from the standpoint of ordinary macadam construction, the same is not true of broken-stone roads which are carpeted or constructed with an adhesive bituminous material. The French coefficient of wear is also of relatively less importance, owing to the fact that the fine mineral particles produced by the abrasion of traffic combine, or should combine, with the bituminous material to form a mastic which is held in place and protects the underlying rocks from abrasion so long as it is kept intact by proper maintenance. The toughness of the rock is of more importance, as the shock of impact is to a considerable extent transmitted through the seal coat and may cause the underlying fragments to shatter. It would, therefore, seem that the minimum toughness of a rock for use in the construction of a

[1] It is the purpose of this chapter to indicate the methods followed in several sections of the country where bituminous roads have been built extensively rather than to recommend any methods as the best for all conditions. Revised by P. St. J. Wilson, chief engineer, United States Bureau of Public Roads, and W. R. Farrington, division engineer, Massachusetts Highway Commission.

[2] From Bulletin 370, United States Department of Agriculture, "Physical Tests of Road-Building Rock," by Prevost Hubbard, chemical engineer, and Frank H. Jackson, Jr., assistant testing engineer, Bureau of Public Roads.

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bituminous broken-stone road or a broken-stone road with a bituminous-mat surface should, for light traffic, be no less than for ordinary macadam subjected to the same class of traffic. For moderate and heavy traffic, however, the same minimum toughness should prove sufficient, owing to the cushioning effect of the bituminous matrix. No maximum limit of toughness need be considered for any traffic.

In the case of bituminous concrete roads, where the broken stone and bituminous material are mixed prior to laying and consolidation, it generally appears advisable to set a minimum toughness of 6 to 77 for light-traffic roads, instead of 5, in order to insure that the fragments of rock which have been coated with bitumen shall not be fractured under the roller during consolidation; and 12 or 13 for moderate and heavy traffic, instead of 10 and 19, as in the case of water-bound macadam roads.

Bearing in mind the fact that availability, cost, and various local conditions generally control the selection of proper limits, the accompanying table may be used as a general guide for minimum limits of the French coefficient of wear and toughness in connection with bituminous broken-stone roads.

Bituminous Materials

Climatic conditions, the volume and character of traffic to be carried by a road, the kind of stone to be used, and the methods of construction vary greatly in different places and have an important influence on the determination of the bituminous materials to be used. For this reason it is not practicable to have a general specification of universal applicability. The requirements for bituminous binders for a number of States are given in the chapters on asphalts and tars.

In most cases the binders are furnished by the contractors under specifications of greater or less detail. In Massachusetts the State highway commission usually purchases its material and furnishes it to the contractors, although contractors are occasionally required to supply it.

Bituminous Macadam

Roads of this type are frequently said to be built by the "penetration" method because the bituminous material is made to penetrate the interstices of the road from the surface. The grading, drainage and rolling of the subgrade are carried out as in the case of waterbound macadam roads. On the subgrade is laid a base or bottom course, then a top course to which the bituminous material is applied, and finally a thin "seal" coat of bituminous

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material covered with screenings or gravel to protect the main mass of the road from the weather and other deteriorating influences.

Limits of Physical Tests of Rock for Bituminous Roads

(Recommended by Prévost Hubbard and Frank H. Jackson, Jr.)

	Light to Moderate Travel			Moderate to Heavy Travel		
	French Coefficient	Percentage of Wear	Toughness	French Coefficient	Percentage of Wear	Toughness
	At least	Not over	At least	At least	Not over	At least
Broken stone with bituminous carpet	5	8	5	7	5.7	10
Bituminous macadam with seal coat	5	8	5	7	5.7	10
Bituminous concrete	7	5.7	7	10	4	13

Gallons of Bituminous Material per Mile of Road for Different Rates of Application

Gallons Per Square Yard	Width of Road in Feet						
	9	10	12	15	18	20	22
0.20	1,056	1,174	1,408	1,760	2,112	2,347	2,582
0.25	1,320	1,467	1,760	2,200	2,640	2,933	3,227
0.33	1,742	1,936	2,323	2,904	3,484	3,872	4,259
0.40	2,112	2,347	2,816	3,520	4,224	4,694	5,163
0.50	2,640	2,934	3,520	4,400	5,280	5,867	6,454
0.60	3,168	3,520	4,224	5,280	6,336	7,040	7,744
0.67	3,538	3,931	4,716	5,896	7,075	7,862	8,648
0.70	3,696	4,107	4,928	6,160	7,392	8,214	9,035
0.75	3,960	4,400	5,280	6,600	7,920	8,801	9,680
0.80	4,224	4,694	5,632	7,040	8,448	9,387	10,326
0.90	4,752	5,280	6,336	7,920	9,494	10,561	11,616
1.00	5,280	5,867	7,040	8,800	10,560	11,734	12,907
1.25	6,600	7,334	8,800	11,000	13,200	14,668	16,134
1.50	7,920	8,801	10,560	13,200	15,840	17,601	19,361
1.75	9,240	10,267	12,320	15,400	18,480	20,535	22,587
2.00	10,560	11,734	14,080	17,600	21,120	23,468	25,814

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The depth of the bottom course varies with the character of the subgrade, the traffic, the quality of the stone, the character of the top course and the preferences of the highway authorities. Probably 6 inches at the center and 4 inches at the sides are average depths.[1] In Massachusetts, where the foundation is prepared very carefully, sometimes consisting of 12 inches or more of gravel or telford, an 18-foot roadway usually has a bottom course from 2 to 3 inches thick at the sides and 3 to 4 inches thick at the center, after rolling, except on stone foundations, where the standard thickness is 2 inches at all points of the cross-sections. These thicknesses are increased in some cases.

The Massachusetts specifications call for smaller stone than those of most States, and give the engineer the final decision regarding the proportions of the ½ to 1¼-inch size and the 1¼ to 2½-inch size which shall be mixed together for this course, the intention being, where stone is crushed locally, to vary these proportions in order to use the output of the crusher.[2] In New York and Pennsylvania the maximum size of the stone for this course is 3½ inches. The Pennsylvania specifications require the stone to have a French coefficient of wear of not less than 10, and permit the use of gravel and of broken slag which weighs 70 pounds or more per cubic foot, measured loose. In Ohio, if sandstone is used in the bottom course, pieces as large as 6 inches are permitted; the maximum size with other rocks is 4 inches. In Illinois and California the maximum size is 3 inches. These variations are due mainly to differences in the average quality of stone available in the different States.

After the stone has been spread, it is sometimes harrowed. The Illinois specifications call for the use of a tooth harrow weighing 10 to 12 pounds per tooth. The course is then consolidated with a roller, one weighing 10 tons or more being generally required. It is next covered with screenings, small gravel and sometimes coarse sand, which are broomed and rolled dry until the interstices are filled, but not over-filled. Some engineers consider the course finished at this stage, while others require it to be sprinkled with water and rolled so as to consolidate it still further.

On the work under a number of State highway departments, the stone for both the top and bottom courses must be shoveled from the carts into place, or be dumped on platforms and shoveled from there into place, or be spread over the road by distributing

[1] On roads where the traffic promises to be heavy, it is often considered best to have the same depth the entire width of the road.

[2] When imported stone is used, ordinarily only the 1¼ to 2½-inch stone is used.

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wagons built for that purpose. In other States the stone for the bottom course may be dumped on the subgrade and shoveled from these piles into its final place. Stone for the top course is never permitted to be dumped in piles on the bottom course. The screenings or other fine material used on the road are generally required to be delivered along the road before construction begins.

Other types of bottom courses than those made of graded aggregates are occasionally used. Many macadam roads in good condition have had a bituminous macadam top course put on them. Macadam roads when in poor condition are often scarified, new material added where needed, and then rolled, thus furnishing a suitable bottom course at minimum expense. If these old roadways are thus used, their drainage should be carefully examined and all defects remedied before the top course is laid. In the New York State highways, a base of run-of-bank gravel not larger than 3½ inches is sometimes used. In this case the material passing a ¼-inch screen must not be more than 5 per cent in excess of the voids in the remainder of the material after this fine stuff has been removed.

In Massachusetts the top course is usually 2 inches thick, and as stone from 1¼ to 2½ is required, the largest pieces become imbedded slightly in the bottom course by the rolling. More than 15 per cent of the ¾ to 1¼-inch stone, which is permitted in the bottom course, is not desired in the top course because experience has convinced the Massachusetts engineers that its presence makes a less durable road. More bituminous binder is required with coarse than small stone, but the entire quantity can be applied at one time, while if small stone is used it has been found desirable to construct this course in two layers in order to be certain that the smaller voids existing with such stone are filled.

The top course in most States is usually from 2 to 3 inches thick.

The top course of the New York State highways is made of 1¼ to 2½-inch stone in Pennsylvania 1 to 3-inch, in Ohio 1½ to 2½-inch stone for a course less than 3 inches thick and 2½ to 4-inch stone for a course 3 inches or more thick, unless the stone has a loss on abrasion of less than 6 per cent, when the size is reduced to 2 to 3½ inches; in Illinois 1 to 2¼ inches. The Ohio and Illinois specifications require it to be harrowed.

In rolling this course, it is usually considered desirable to roll adjacent strips of the shoulders as well, so as to unite the shoulder and roadway as completely as practicable. It is also generally considerable desirable to roll the stone until it is "locked" in place so the binder distributor can pass without leaving any im-

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pression, but not to the maximum density. The reason for this is that the bituminous material is believed to be more uniformly distributed if the course of stone is capable of further compression after the binder has been applied. Some stone hard enough to carry travel should not be rolled heavily, for if heavily rolled the voids will be so reduced that the binder will not penetrate into them properly.

No bituminous material should be applied except when the stone on the surface is clean and free from dust. The application is now made in most cases with a pressure distributor, which is required by some State highway departments; it is also applied by gravity distributors and, on small work, by hand-pouring cans.

Distributing wagons often have some kind of fire-box for keeping the binder hot. Gravity distributors discharge their contents through nozzles or other spraying devices at their rear about 12 inches above the road. The shape and location of the nozzles are so selected that the binder will be distributed uniformly over a strip of the road somewhat wider than the distance between the wheels. The binder flows from the nozzles by gravity, and as the contents of the tank are drawn off the pressure on the nozzles decreases and the rate of flow per minute is reduced. In order to maintain a uniform flow, a control valve in the outlet pipe is provided. The rate of application of the material is regulated by this valve and the speed of the distributor.

Pressure distributors are used where it is desired to have better control over the rate of application of the binder than is practicable with gravity distributors, and also to obtain the best distribution and penetration. In some types, compressed air or steam is admitted to the top of the tank so that the pressure on the surface of the binder, whether the tank is full or almost empty, is sufficient to drive the material through the nozzles with considerable force. In other types, the binder is driven out of the nozzles by a small pump. The nozzles of the pressure distributors are generally about 6 inches from the surface of the road. In some cases the binder is forced through a hose ending in a nozzle which the operator moves along just above the surface of the road.

Portable heating kettles with gas-engine operated pressure distributor mounted on the kettle for applying the bituminous material through hose, and spray nozzles are also used. In applying the kettle is usually drawn by a steam roller.

Bituminous material has been distributed from tank wagons without any suitable piping and nozzles of their own. This is done by attaching to their rear end a light two-wheel sulky having the necessary distributing apparatus, which is connected by piping

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with the outlet of the tank wagon. Attachments are also made for this purpose which can be bolted to an ordinary tank wagon.

Pouring cans resemble garden watering cans in appearance. The top is usually partly covered to prevent the binder from slopping out, and there is generally a removable screen which intercepts anything likely to clog the nozzle. The nozzle is a slot 6 to 10 inches long, which is usually adjustable. A skillful man can apply bituminous material in this way very uniformly, but the expense on large work is greater than with distributors.

The binder can be heated in portable kettles, usually mounted on wheels, in distributing wagons, oil heating pits, or in tank cars, the method to be followed depending upon the amount of material to be heated.

The amount of binder used is from 1¼ to 1¾ gallons per square yard, depending upon the depth and size of the stone. If an asphalt binder is used it must be applied at a temperature of about 300°F. and if tar at about 200° to 225°F. After it is spread it is covered with small stone, usually from about ¼ to ¾ inches in size; in New York State work stone of ⅝ to 1¼ inches is specified. In Massachusetts good results have been obtained in some cases with sand. After this dressing has been spread it is often gone over with brooms to make certain that all voids in the surface are filled, and the material uniformly distributed, and the brooming should be finished with the brooms working parallel with the line of the road.

After the top course has become firm under the roller, the surface is swept clean and the seal coat is applied. This is usually spread at the rate of 1/3 to ¾ gallon per square yard, and is covered with ¼ to ¾-inch stone chips or pea gravel. The road is then broomed, using a lock street broom for the purpose, and then given a thorough rolling so as to consolidate it as much as possible and the broom can be attached to the roller during this final rolling. A liberal use of both the hand broom and the lock street broom, or the broom fastened to the roller, during the screening and finishing of the road will do much to insure that the dressing is evenly taken up by the oil and a smooth riding surface obtained that will not start the pounding of automobiles and the consequent rippling of the surface.

In the State highway work of Illinois, there are three courses and a seal coat in bituminous macadam construction. The second course is 1 to 2¼-inches stone, harrowed, rolled, and treated with 1 gallon of binder per square yard. This is covered with ¼ to ½-inch screenings, which are broomed into the voids and the excess swept off. A second application of binder is then made at the rate of ½ gallon per square yard and covered with torpedo

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gravel ranging in size from ⅜-inch down to fine sand. This is broomed until the voids are filled, when the surplus is removed. Another application of binder is made at the rate of ½ gallon per square yard and covered with torpedo gravel at the rate of about 1 cubic yard per 200 square yards of road. The wheels of the roller may be wet to prevent them from picking up the binder; some engineers object to such wetting and require the wheels to be oiled.

Where the grade is steep, the Massachusetts highway commission has recently tried the practice of leaving the surface rather rough, so as to afford a foothold for horses and resistance to skidding for automobiles.

Bituminous Concrete

When the stone and binder are mixed together thoroughly before they are placed on the road, it is practicable to use both small and large stone and thus reduce the volume of the voids to be filled with bituminous binder. This material is placed on any of the bottom courses used with bituminous macadam and also on concrete. It is essential for the bottom course to be dry and clean when the mixture is spread over it.

The size of the stone required by different State highway departments varies somewhat, and some departments have a number of standard proportions. In Massachusetts crusher-run trap from ¼ to 1½ inches is specified for some roads, and also crushed gravel, which will be mentioned later. In New York ⅝ to 1¼-inch stone is used for a course 2 inches or less in thickness, and for thicker courses stone up to 2¼ inches in size is allowed. In both New York and Maryland materials are permitted which will give a finished pavement with less than 10 per cent passing a 2-mesh screen, 8 to 22 per cent passing a 4-mesh, 25 to 55 per cent passing a 10-mesh, 18 to 30 per cent passing a 40-mesh, 5 to 11 per cent passing a 200-mesh, and 7 to 11 per cent of bitumen. In Maryland a mixture is also used containing two parts of ¼ to 1¼-inch stone and one part of sand with 25 per cent passing a 20-mesh screen and 5 per cent passing 80-mesh. To this mixture is added 5 per cent of powdered limestone or cement and 7 to 9 per cent of bitumen. In Illinois the proportions are left to the engineer, but the purpose is to obtain the equivalent of a thorough mixture of 1 cubic yard of grit sand passing a ⅜-inch ring with 40 to 80 per cent passing a 10-mesh sieve, and 3 cubic yards of ¾ to 1½-inch stone with 30 to 80 per cent retained on a 1-inch ring. Instead of the stone, 3 cubic yards of ⅜ to 1-inch gravel with 20 to 70 per cent retained on a ⅜-inch screen may be used.

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The amount of bituminous binder on the Massachusetts work is about 20 to 24 gallons per cubic yard of stone. In New York, for the work with broken stone without fine material, 18 gallons are used per cubic yard of stone and the purpose is to have the finished course contain from 5 to 7½ per cent by weight of bitumen. On the Illinois work, from 27 to 30 gallons of binder containing 95 per cent or more of bitumen is used per cubic yard of stone or gravel, and if the binder contains less than 95 per cent of bitumen the quantity must be increased proportionately.

Although stone and tar binder have occasionally been mixed cold, as in Rhode Island, it is customary to mix the stone and bituminous material hot. There is a marked difference of opinion regarding the temperature to which the stone should be heated, Massachusetts requiring this to be 180°F. or more and Illinois 300° to 375°. A high temperature will injure some binders and not others, and it is therefore important to have the aggregate uniformly heated to the proper temperature for the binder used, the weather conditions, and the length of haul from the mixing plant to the road. The binder is heated in kettles or tanks. The temperature for asphalt is 275° to 375° and for tar 200° to 275°, the limits varying somewhat with the grades used. Special care must be taken to prevent overheating. Sometimes hot stone and cold binder are mixed. The mixing on small work can be done by hand, but is more quickly and thoroughly performed on large work in mixers made for the purpose.

The best equipment for any contract will depend upon local conditions, among which the transportation of the mixed material is an important factor. The mixture must be delivered on the site at temperatures of 150° to 280°, according to the binder used. The maximum permissible drop between the temperatures of the material at the mixer and when it reaches the road, freedom from segregation in the mixture, and the practicable speed of delivery, fix the maximum length of haul. If the maximum length of haul permits the use of a central plant for the whole work, it is often practicable to locate it at the crusher plant and save some labor charges. Portable plants for use along the road have been greatly improved in recent years and are used extensively.

The wagons for transporting the mixture should be tight, and under some weather and hauling conditions their contents should be covered with canvas to keep them from becoming chilled. The bodies of motor trucks are sometimes jacketed or insulated for the same purpose.

The mixture should be shoveled from the wagons, or dumped on wood or metal platforms from which it can be shoveled. The shovels are often heated, as are the rakes used in spreading the

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mixture. It is considered desirable by some engineers to prohibit delivering hot mixture on the road within one hour of sunset.

When the edges of the pavement are not protected by a stone or concrete curb, the New Jersey highway department requires the contractor to place temporary curbs of 6 or 8-inch planks of the same thickness as the finished top course.

When it is necessary to lay half of the width of a road so as to allow traffic on the other half, the base of the first half is allowed to project about 2 feet beyond the center line of the roadway. The top course in such cases ends only a few inches beyond the center line, for this will insure all of it resting on a firm base. After the second half of the base has been constructed, the inside edge of the top course already laid is cut back vertically or nearly so along a straight or properly curved line so as to obtain a perfect joint with the second half of this course.

After the material has been spread it should be rolled immediately. Sometimes an initial compression is given with a 3- to 6-ton tandem roller and the final compression with a 10-ton macadam roller, but the usual practice is to use a 7- to 10-ton roller giving 200 to 300 pounds per linear inch of roll. The wheels may be oiled to prevent the binder from sticking to them. This rolling is continued until the roller leaves no marks in passing. Any places which can not be reached by the roller are rammed with a hot iron tamp.

The road is often given a seal coat at the rate of 1/3 to ¾ gallon of binder per square yard, which is at once covered with pea stone or grit. The binder is often the same material used in the bituminous concrete, but sometimes it is a more fluid grade. Some engineers require it to be applied with a squeegee distributor. The seal coat is rolled until it is thoroughly incorporated with the top course.

Mixed Gravel-Asphalt Roads

The Massachusetts highway commission has built a number of roads with mixed gravel-asphalt surfaces on both gravel and broken-stone bases. On broken-stone bases (or crushed gravel) the surface is usually 2 inches thick, and on gravel 2½ inches thick. The width of the surface is ordinarily 18 feet, with a 3-foot shoulder, but the curves are banked and the surface widened on curves to not less than 21 feet. In some cases the aggregate for the surface has consisted of a bank run of gravel after having screened out stone larger than 1½ inches in diameter. Where such a surface is used, the base has been either of bank run of gravel or an old worn-out broken stone road. The gravel base

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is usually from 4 to 6 inches in depth after rolling. Where crushed gravel is used, stone from 1¼ inches to 2½ inches in diameter is used for the base and all material passing the 1¼-inch screen is used for the surface. If there is not a sufficient amount of stone in the bank run of gravel, crushed field stone is added. In some cases cement or limestone dust has been added to the aggregate for the surface, but it is probable that while better results are obtained that the results do not warrant the additional cost. The surface is usually rolled with a 6-ton tandem roller and from 18 to 24 gallons of hot asphalt have been used per cubic yard of aggregate, asphalt with a penetration (Dow penetrometer) as low as 56 has been used, but ordinarily material with a penetration of from 90 to 110 is advisable.

Sand and Oil Roads

In 1905 the Massachusetts highway commission surfaced a road at Eastham by distributing hot asphaltic oil over the sand, which is practically the only material in the vicinity, applying 1½ gallons to the square yard in two applications. The results were so encouraging that more sand-oil roads have been built and the experience thus gained has shown what are the requirements for success. Both the penetration or layer method and the mixing method have been used in the past, but at present only the mixing method is used on State highway work. The layer method is, however, still used on some town work. Sand and oil roads are considered suitable when the traffic is mostly light teams and automobiles and will not stand up if used daily by many heavily loaded teams. The average daily traffic in 1915 on one successful layer road was 20 heavy teams, 17 light teams and 253 automobiles. On a mixed road it was 6 heavy teams, 23 light teams and 505 auotmobiles; on another mixed road 21 heavy teams, 38 light teams and 197 automobiles. The census taken in 1918 on one mixed sand and oil road showed an average of 22 horse-drawn vehicles, 789 automobiles and 27 trucks. No census was taken in 1918 on the layer roads.

It is desirable for success to use a hard, strong, sharp and well-graded sand, such as is abundant on Cape Cod, where this type of construction has been developed. Many sands are too fine, too uniform in size, too rounded or not strong enough. Fair results have been obtained with some fine sands, however.

An oil asphalt of good quality that will bind and not lubricate must be used. For the layer type, the preference in Massachusetts is for an oil with a viscosity of 150 to 200 seconds at 200°C., using a Lawrence viscosimeter or about 1038 to 1384 with 100 cc,. at 100°C. in an Engler viscosimeter. From 1½ to 2 gallons

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per square yard are used, in two applications, with a covering of sand after application. In the mixed type, oil asphalts having a penetration of 60 to 135 by the Dow penetrometer have been tried, but that now used ordinarily has a penetration of 90 to 125. From 16 to 22 gallons per cubic yard of sand have been used; the present average is 18 gallons. The Massachusetts commission advises testing each carload of oil before using it.

In the layer type of construction, clay or loam is spread over the sand subgrade to reduce the rutting of the surface by wheels and pitting by horses' hoofs when the oil cart passes over it. The oil is then spread evenly while hot with a distributing cart and immediately covered with sand. This process is then repeated.

In the mixed type of construction the sand and oil are mixed hot to form a mastic which is spread over the sandy subgrade and rolled. The subgrade is carefully shaped and hardened as in the case of the penetration type. The mastic sheet is about 4 inches thick at the center and 3 inches at the edges. The best results have been obtained by keeping the road constantly shaped with a road scraper during rolling, and a seal coat of ½ gallon of a lighter oil such as is used in layer work improves the surface and decreases maintenance charges. In the early work the sand was heated on sheets of iron, but this overheated parts of it and underheated other parts, so that now the heating is done in rotary heaters.

If the traffic in the future proves too heavy for these roads, the commission believes they can be greatly improved and strengthened at a moderate cost by using harder asphalt, greater care in grading the sand, and the addition of cement and stone dust. In this way a sheet asphalt pavement 2 inches thick can be laid on the old sand-asphalt road as a base.

Asphalt Blocks on Country Roads

As designed and manufactured for use on country roads, the asphalt blocks are 5 inches wide, 12 inches long and 2 inches deep, weigh about eleven pounds each, and have a specific gravity of about 2.40.

The asphalt block was developed and perfected on the theory that crushed trap rock, on account of its preëminent hardness and inherent grittiness, made the best known material for a roadway surface, the one thing needed being a cement, or binding material, to keep all of the particles permanently in place. This was accomplished by the use of an asphaltic cement to bind together the properly graded particles of crushed trap, the hot mixture being consolidated by tremendous pressure into blocks so dense and free from voids as to be practically non-absorbent. In the asphalt

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block, therefore, we have an asphaltic concrete, or macadam, mixed, in exact proportions, at a central plant, under conditions insuring absolute uniformity, and receiving the compression necessary to produce a dense and non-absorbent material.

Not only has a special block been produced, but a special method of construction has been worked out, designed to utilize what is left of the worn and rutted macadam road as a foundation for the blocks. This is accomplished by scarifying the surface, if necessary, filling up the deep ruts, rolling with a heavy steam roller, and laying upon the surface of the old macadam a bed of cement mortar about 1 inch in thickness, to serve the double purpose of forming a firm unyielding bed for the blocks, and binding them securely to the macadam foundation underneath. By this method the material used in the original construction of the road is not thrown away, but used as foundation for a permanent wearing surface. Where the old macadam is too thin, or too badly worn to be safely used as a foundation, it will be necessary to lay a concrete base, but usually there is broken stone enough in the old macadam to supply what is needed for laying concrete.

A pavement may be laid of any desired width, contour, grade, or crown. It is perfectly feasible to pave one-half of the roadway, or only a narrow strip in the center, and extend the paved area at a later date as traffic necessities require, or as appropriations become available. It is not necessary to set curbstones or heading stones to border or define the paved area, since a row of stretcher blocks held firmly in place by a shoulder of mortar, answers the purpose perfectly and leaves the entire roadway surface smooth and uniform.



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CONCRETE ROAD CONSTRUCTION[1]

The concrete road has become in the past few years well known throughout the country, as the great increase in the yardage of this type of pavement will bear witness. While prior to 1909 there had been constructed but 591,416 sq. yds. of this type of pavement, there had been laid at the close of 1919 a total of 167,000,000 sq. yds. During 1918 there was built 16,800,000 sq. yds. and in 1919 about 53,500,000 sq. yds.

Briefly these are some of the characteristics of the concrete road by which may be demonstrated its adaptability to meet the requirements of modern traffic: It has low first cost as compared with other types which will meet the requirements; low maintenance charge; materials for its construction are widely dispersed and of common occurrence; may be constructed without employment of peculiarly skilled laborers; possesses an even surface affording a low tractive resistance, combined with such a surface texture as affords a good grip for the wheels of fast moving traffic. This reduces to a minimum the dangers of skidding. Owing to the fact that it cannot be gullied or washed away by storm waters, it may be laid with a minimum amount of crown—a good feature for any road subjected to motor traffic. It is because of these desirable features that the concrete road has made such rapid strides.

As is common with all forms of construction, the methods of laying concrete pavements have undergone change and development. The construction features, therefore, of concrete highways will be dwelt upon particularly to bring out this development in some of the operations involved. The practical application of the results of investigations and research will also be pointed out.

Structural Features

Width.—In the design of a road, there are two essential dimensions—width and thickness—which must be determined and which it is evident are the chief factors controlling the cost per unit of length. As it is always the endeavor to make this cost as little as possible, too many roads are made both too narrow and too thin.

As the thickness of the pavement is to a certain extent a func-

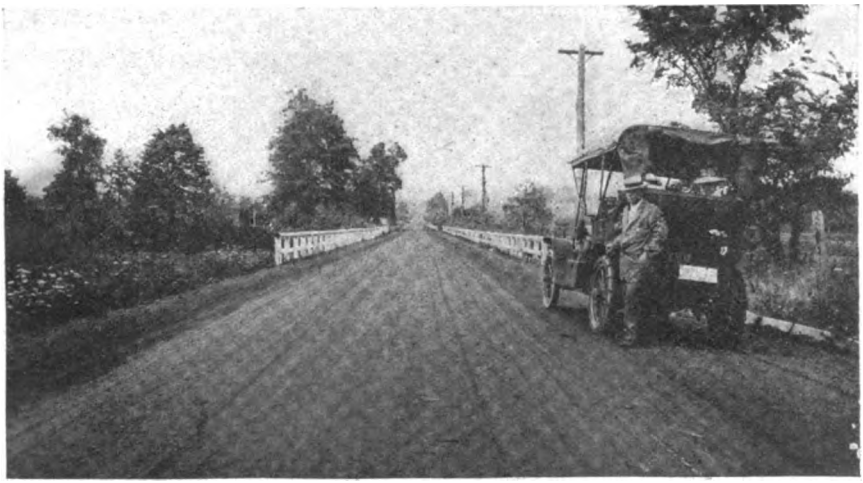
[1] This chapter on Concrete Road Construction follows closely the text of one of the J. E. Aldred Lectures on Engineering Practice at the Johns Hopkins University, Baltimore, 1917-18, by A. N. Johnson. Some slight changes have been made which bring the text up to date.

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Highway Types of Today



Surface—Treated Gravel



Surface—Treated Macadam

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Highway Types of Today



Bituminous Macadam



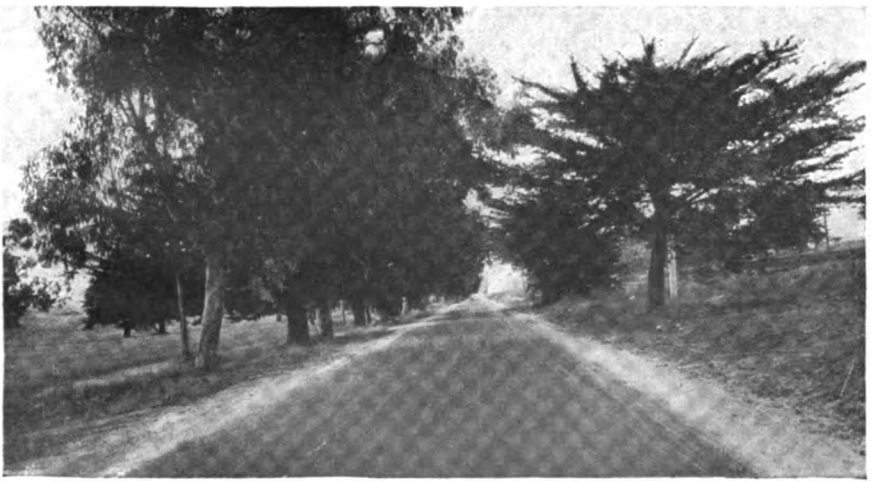
Asphalt Block

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Highway Types of Today



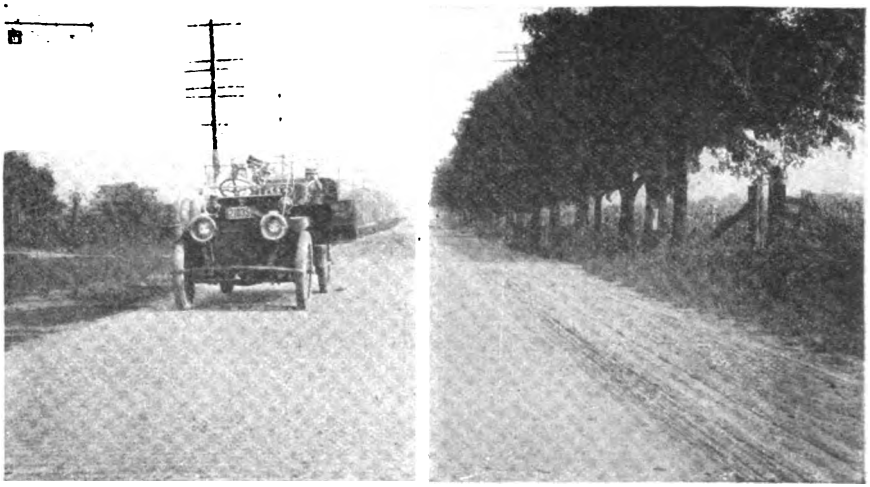
Cement Concrete



Bituminous Covered Cement Concrete

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Highway Types of Today



Brick



Stone Block

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tion of the width, the width is the dimension to be first determined.

Where a single-track road is constructed it is an utter waste of money to make it wider than is necessary for single-track traffic, if such a width is not sufficient for two lines of vehicles. Ample experience has demonstrated that 9 or 10 feet gives a width sufficient for a single line of motor vehicles to be operated with safety and comfort. Therefore, to construct a 12, 13 or 14-foot width is merely to waste the extra 3, 4 or 5 feet of pavement, as the case may be. As it is certain that it will be but a short time before the community discovers that the single track is insufficient, roads should be so built as to make it possible to widen to a two-track road at a minimum expense in the future. It should, therefore, be laid with one edge at the center of the right of way of the highway.

The majority of roads are now being paved for at least two-track traffic. It should require no argument to convince anyone who has had any experience on roads of less width under our modern traffic conditions that 18 feet is a minimum to allow for two-track traffic. Anyone possessed of the slightest vision should realize that on our main roads a less width is barely short of criminal. The next practical width should be one that would accommodate three lines of traffic. Such a width of road is called for where at a given time of day there is considerable traffic movement in one direction which is reversed at a later period of the day. A three-track road under such circumstances may be as serviceable as a four-track road. For each line of traffic to be accommodated, 9 feet is a minimum width to allow. A better width, one that will prove to give greater safety and comfort, would be 10 feet. And the time is not far distant when we shall see hundreds of miles of roads constructed 30 and 40 feet in width to accommodate intertown highway traffic.

Thickness.—The proper thickness for a pavement of any good type must at best be founded on empirical rules. It is a fact, as with many other features of highway design, we have no data on which to base sound conclusions as to the proper thickness. The increase in the weight of loads which are hauled, and will be hauled over our highways, makes it all the more necessary that an investigation should be made which will determine this very important factor.

The general practice in concrete road construction has been to place roads of 18 to 30 feet in width with a thickness of 6 inches at the sides and from 8 to 9 inches at the center.

Crown.—It has been, until quite recently, the general practice to make the crown on concrete roads about 1/100 of the width.

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But, with the improvements that have been made in the manner of finishing a concrete road, particularly with finishing machines, 18 and 20-foot roads are constructed with crowns that do not much exceed 1 inch.

Super-Elevation.—The super-elevation of pavements around curves is generally recognized as adding to the safety of the highway. Two purposes are accomplished—first, to make them safer against skidding, and, second, to induce traffic to keep to the right side of the road and not tend to cut toward the inside, as is the general tendency on roads crowned in the ordinary manner around curves, thus avoiding collisions.

The amount the pavement should be super-elevated at curves should not exceed ¾ inch per foot for curves of 150 feet radius or less. For curves 150 to 500 feet radius, ½ inch per foot is sufficient, while pavements around curves of greater radius than 500 feet may be constructed with the usual cross-section as on level stretches.

An added safety feature at curves is to arrange embankments and other obstructions so as to give a clear sight of not less than 500 feet.

Widening Turns.—To add to the safety of highways at curves, the pavement and the shoulder should be widened; particularly the shoulder on the outer edge of the curves where the radius of the curve is less than 500 feet. The ditch on the outer side of the road is to be placed as far away from the pavement edge as the right of way will permit.

The increase in motor traffic is making more and more important attention to these details of construction which will add to the safety of the traveling public.

Grading and Drainage

Grading.—The profile that is fixed determines the amount of grading necessary. In general the requirements for grading for concrete roads are not essentially different from those pertaining to roads of other types of construction. So there is little to be suggested that is peculiar to concrete roads.

One point which may well be emphasized is the profile to be established at railroad crossings. When it is not practicable to effect a separation of grades, grade crossings can be made much safer than otherwise if care is taken to have the road surface for a distance of at least 50 feet on either side of the railroad track at the same elevation as the top of the rails. Similarly on approaches to bridges it is desirable that the surface of the road, for at least 50 feet, at each side of the bridge, shall be at the same elevation as the bridge floor.

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Drainage.—Drainage is an essential feature of a properly constructed road. It is perhaps the one feature of construction upon which there is more common agreement as to the statement of the principle, and less specific information as to what and how to do that which is required. The reason for this is not difficult to see. The general features of road drainage are divided between surface and sub-drainage. The requisites for surface drainage demand a proper road crown, slope of the shoulders to the gutters, and outlets for the water from the gutters through culverts and small bridges. Sub-drainage is effected usually by laying a tile drain and back-filling the trench in which the drain is laid with rock, gravel or other porous material.

The difficulty lies not so much in lack of understanding as to how to construct the drainage, as to be able to determine the type of drainage structures that will be required on a given piece of road. There is called for, on the part of the engineer, the exercise of more judgment than is necessary in almost any other portion of the work. It is because of the fact that the proper drainage of a road does depend on the exercise of sound judgment, gained only through much practical experience, that it is impossible to set forth in text, rules that will be in the same measure a guide to the engineer as is possible with many other features of the construction.

During the past two years, when so many stretches of road were subjected to unusually heavy traffic, due to army motor trucks, weak places were developed that had not before appeared under the normal traffic. With increasingly heavy loads it becomes necessary to provide a more nearly perfect drainage system, for in most places where the failures occurred there was a large amount of water in the subsoil which was not properly cared for by sub-drainage.

Materials

"It is most advisable that all construction of concrete roads and pavements should be done under laboratory control. This control should extend to the testing, sampling, and a certain amount of field inspection, of all concrete materials. Testing and sampling are to be done prior to the acceptance of materials for use in any concrete road or pavement.

"The object to be accomplished by laboratory control is to determine, prior to use, whether or not the materials available are of proper quality; also this would enable the laboratory representative to determine and suggest the proportions which would give the best results. All laboratory control must be based on certain

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tests of the constituent materials, of the finished concrete and an interpretation of such results."[1]

Quality of Materials.—The specification for materials for concrete have undergone some changes. It was formerly the custom to elaborate in the greatest detail all of the tests and requirements to which the cement should be submitted and but a line or two covering water, fine and coarse aggregate. It has become more and more evident that equally as close attention should be paid to the character of the other materials. Specifications for sand have, as a consequence, been developed that describe in considerable detail the characteristics it should possess. The amount of clay or silt is limited to a few per cent and methods of determining the amount of silt have been elaborated and perfected.

There have occurred, however, some failures of concrete for which no cause was apparent. The quality of all materials appeared to be good. Recent investigations by Professor Abrams, conducted at the Structural Materials Research Laboratory of the Lewis Institute, Chicago, have brought out the fact that organic impurities, even in extremely small quantities, when present in the sand are sufficient to cause failure of the concrete.

That concrete of good quality has been made in many instances with sand containing even a considerable proportion of clay, is explained by the fact that the clay contained no organic impurities. As a result of these investigations a very simple and convenient field test has been devised by which it is possible to determine whether a given sand contains a dangerous amount of organic materials. This test is known as the "colorimetric test." The method for field determination consists in shaking the sand thoroughly in a dilute solution of sodium hydroxide (NaOH), ordinary caustic soda, and observing the resultant color after the mixture has been allowed to stand for a few hours. A 12-ounce graduated prescription bottle is filled to the 4½-ounce mark with the sand to be tested. A 3 per cent solution of sodium hydroxide is added until the volume of the sand and solution, after shaking, amounts to 7 ounces. It is then shaken thoroughly and allowed to stand 24 hours. A good idea of the quality of the sand can be formed earlier than 24 hours, although this period is believed to give best results.

If the solution resulting from this treatment is colorless, or has a light yellowish color, the sand may be considered satisfactory in so far as organic impurities are concerned. On the

[1] From the "Recommended Practice for Concrete Road and Street Construction" of the American Concrete Institute, 1919.

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other hand, if the solution be a distinctly brown tinge, the sand should not be used for concrete road work.

The conclusions are that it is the presence of organic impurities of a humus nature that is responsible for most defective concrete sands, and the colorimetric test furnishes a simple and inexpensive method for detecting the presence of such impurities. The test made in the manner as here described will be found useful for:

(1) Prospecting for sand supplies.
(2) Checking the cleanness of sand received on the job.
(3) Preliminary examination of sands in the laboratory.

The grading of aggregates has come to be generally recognized as important, but most specifications have been content to state that the sand and rock should be well graded. Some have gone a step further and indicated the amount of material below a certain mesh sieve which should be allowed. This whole matter has been made the subject of most exhaustive investigations by Professor Abrams, which show clearly just what is the relation between grading and strength of the resulting concrete. When Professor Abrams has finished his investigations we shall, for the first time, be able really to design concrete, as one of the most important results of his researches will be to enable the engineer to predict with considerable certainty the strength that may be obtained with a given amount of cement and given aggregates.

Handling Materials.—It was common practice on the earlier concrete roads to haul the materials to the work by teams. The subgrade being prepared, materials were dumped upon it ready for use in the mixer into which they were shoveled by hand. On most of the work it was customary to handle the materials by means of wheelbarrows which were used as measuring boxes. It is thus clear that the hauling and handling of materials to the mixer constituted a large portion of the expense of laying a concrete road, being from 30 to 35 per cent of the total cost.

An opportunity was presented for a very considerable saving in handling these materials and special attention was given to this phase of the work as larger contracts were awarded and a much longer mileage constructed at one time. After a trial of a number of methods, including motor trucks and tractors with trailers, the most satisfactory and most economical method has been the industrial railroad which runs upon a narrow-gauge, light track which is laid from the point the materials are received extending thence alongside the road to be constructed. It still remained the practice to dump the materials on the roadbed and rehandle them into the mixer, but methods of handling materials

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so that it is unnecessary to store them upon the subgrade have now been developed. The small cars are so constructed that they may be readily removed by a light derrick attached to the mixer and the entire contents of a single car dumped directly into the hopper of the mixer. Each car carries the correct proportions of cement, sand and coarse aggregate.

By the proper track arrangement it is possible to so arrange a distribution of the cars and locomotive that the mixer always has a supply of material and the locomotive is not held for any length of time. This method is not only the most economical yet developed, but has a distinct advantage in that it is not necessary to put the materials upon the subgrade, which avoids getting some of the earth of the subgrade into the concrete, or the other alternative of wasting an appreciable amount of the aggregates. By this arrangement it is possible to haul materials for 10 to 12 miles at a cost that is no greater than for a two- or three-mile haul with teams.

Proportions for Materials.—Concrete roads have been built with considerable variation in the proportion of cement, sand and coarse aggregate. There has come, however, to be a general adoption of the proportion of 1 part cement, 2 parts sand and 3 parts coarse aggregate. While the limiting size on the coarse aggregate was kept rather small at first, not exceeding 1½ inches, the tendency now is to increase this to 2 and even 2½ inches.

It is recommended, however, in proportioning the materials that where the coarse aggregate is 2 to 2½ inches in size, and the sand limit is assumed at ¼ inch, that the proportions be as stated above, 1 part cement, 2 parts sand and 3 parts coarse aggregate. Where the coarse aggregate is limited in size from 1 to 1½ inches, then it is recommended that proportions be 1 part cement, 1½ parts sand and 3 parts coarse aggregate. It will be found that the resulting concrete will be of approximately the same strength in each instance.

The question of proper proportions of aggregate for concrete has been the subject of a most exhaustive investigation by the Portland Cement Association, cooperating with the Lewis Institute. The results of this investigation, it is expected, will be published shortly, when there will be available data by which it will be possible for the first time to proportion concrete materials on a truly scientific basis.

Two-Course Construction.—It is oftentimes the case that there may be obtained locally and cheaply a supply of coarse aggregate which is somewhat soft, not suitable for a good wearing surface, while better aggregate may be had at higher cost. Under this condition the most economical method that will give the best

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results is to construct the lower portion of the pavement of the local material over which is laid a two- or three-inch layer of concrete made with the harder but more expensive aggregate. It is good practice to use a somewhat leaner mixture for the base than for the surface layer. The top course is deposited upon the base while the latter is still soft, so that a perfect bond is insured. It is recommended that the lower layer be rolled, as is later described for the finishing surface, except that the rolling need not be followed by the belt.

The development of the two-course construction has made possible exceptionally high-grade concrete pavements and yet take full advantage of all locally available materials.

Mixing Concrete

Water.—The proportions for the concrete being determined and the aggregates at hand, the most important factor to control in making the concrete is the water. It required extensive laboratory investigations and research to establish this fact.

It is a fact that the amount of water which will give the maximum strength produces a concrete which is so stiff that it becomes extremely difficult to handle practically, so that it is necessary to add water somewhat in excess to get a concrete that may be readily used.

It is not possible to state the exact amount of water that should be used with a given amount of cement and a given amount of aggregate. Different aggregates will take more or less water according as they are more or less porous, but the right amount of water can be told readily in practical work by one or two trials, and if through a change in aggregate it appears too much is being used, the water content may be readily varied to give the consistency required. The consistency may be determined very readily at the point of construction by filling a 12-inch cylinder, 6-inch diameter, with the concrete. The cylinder is lifted immediately and the amount that the concrete slumps or settles is the measure of the consistency. Usually this should not exceed one or two inches.

The fact that a dry mixture does give us a maximum strength makes it, therefore, desirable that those methods should be employed in placing the concrete which will permit using readily as dry a mixture as possible.

Most modern concrete paving mixers are now provided with some water-measuring device so that the quantity of water for a given batch having been determined, this quantity may be repeated automatically.

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Measuring Materials.—As more experience has been gained in concrete road construction, the importance of having uniformly proportioned concrete in each batch has become more generally recognized, so that at present more specifications for concrete roads prescribe special measuring devices that shall be employed, not only to measure water but the fine and coarse aggregate as well.

Time of Mixing.—The time of mixing is an important factor, controlling the quality and strength of concrete. Extended laboratory investigations have demonstrated that the strength of the concrete increases with the time, but that after one or two minutes the increase is much slower than during the first minute. It was not until recently, however, that attention practically had been given to this factor. It has been well established that at least 1 minute mixing should be allowed and this is the requirement found in the majority of state specifications, while some require 90 seconds. The increase in the time of mixing has been one of the notable developments in concrete road building. Much concrete has been spoiled after every precaution has been taken to get proper materials, a generous supply of cement, proper amount of water, etc., by lack of thorough mixing. A number of mixers today are now provided with automatic timing devices so that there will be a given amount of mixing assured irrespective of the operator.

Side Forms

More attention is now given to the placing of side forms than was formerly realized to be necessary. Experience has shown that a number of concrete roads otherwise well constructed have long undulations in the surface clearly attributable to the fact that the side forms had not been held true to grade, particularly where one section of the forms joined its neighbor. It is essential that the side forms shall be firmly supported so that if a heavy tamping template or a machine tamper is used it will not tend to sag the forms at the joints. An excellent way to insure proper support for side forms is first to drive stakes to a firm bearing, with their tops at such an elevation that when the side forms rest upon them their upper edge will be true to the grade of the road.

Where any considerable mileage is under way it is economical for a contractor to equip himself with metal forms. These are usually a channel shape with special devices for holding them firmly in place and at the same time make it possible to remove easily the pins or stakes which support them.

The modern finishing machines use the side forms as a track

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and furnish an added reason that they be placed firmly and accurately.

Placing Concrete

The necessity for care in placing concrete from the mixer onto the subgrade has come to be more fully appreciated as more experience has been gained. If it happens for any cause that a batch of concrete as deposited in the road tends to have portions of the aggregate segregated it is of importance that the concrete shall be redistributed so that there shall be no segregation, particularly towards the surface. The drier the mixture the less tendency there is for this segregation, which furnishes an additional reason for care in the amount of water used in the mixer.

The subgrade should be firm and of as uniform density as possible. If it is dry or dusty it may be lightly sprinkled, but it should not be made wet. Concrete may be deposited from the mixer from an open chute or boom and bucket. If buckets are used which discharge by the opening of doors at the bottom, it is necessary to watch them carefully that no stone lodges in them to prevent their closing tightly. If the chute method is used the pitch of a chute should be steep enough to deliver concrete of a proper consistency.

On some of the earlier roads the concrete was distributed by shovels and not sufficient care taken to insure a true surface. The use of a template to strike the concrete on the narrower roads remedied this to a great extent. On wider roads, those much over 24 feet in width, it becomes very difficult for workmen to manipulate a template extending across the pavement; either the template, in order to be sufficiently stiff, is too heavy to handle, or if light enough to handle is not sufficiently stiff to hold its shape and therefore its purpose defeated.

On pavements wider than 20 feet it is recommended that concrete be distributed by luting. In this method a lute which resembles a toothless rake replaces the strikeboard. The lute is operated so as to place the concrete approximately to the finished section.

Much of the unevenness resulting from inattention or inability to secure a true surface is remedied by the use of a roller. The roller, which is operated transversely to the direction of travel upon the road, has the tendency to smooth out waves in the surface of the concrete which have their axes in a transverse direction, and if waves remain after the use of the roller their axes are longitudinal and, therefore, cause no discomfort or inconvenience to traffic.

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Joints and Reinforcing

Joints.—Joints constructed in a concrete road are of two distinct kinds. The one properly termed an expansion joint is filled with some more or less plastic material, as contrasted with merely a separation of two portions of the concrete with no space between which is properly a contraction joint.

Usually joints are constructed transversely of the road at right angles to its general direction. On a few roads it has been the practice to place the joints at an angle. The object in placing a joint obliquely across the road was to reduce the jar upon vehicles due to inequality of the surface at the joint. In the earlier roads the construction of the surface at the joints had not been perfected and it was not uncommon to find such an inequality. Thus an oblique joint served a very practical purpose. But present methods of construction make it easily possible to have as true a surface at the joints as at any other portion of the road, so that there is no occasion for placing joints other than at right angles.

In the older roads practically all the joints were of the expansion type and their edges were protected by a steel plate. These plates were narrow bands of soft steel about ¼ inch in width and 1½ to 2 inches in depth, held in the concrete by various devices. They were bent to conform to the crown of the road and a pair of them with a ¼ to ½-inch space between were set in the road at the proper place and the concrete deposited about them. The filler between the plates extended to the subgrade, entirely separating the concrete. These protected or armored joints, as they were called, were extremely difficult to place accurately, besides adding considerably to the expense of the road. Moreover, experience soon proved that they served no useful purpose whatever, as it was as necessary to keep them filled with tar or asphalt as joints in which protection plates had not been used. At present the armored joint construction is a rare occurrence.

The theory of the expansion type of joint assumed that after the road was constructed, owing to increased temperature and moisture content, the concrete slabs would expand, for which space should be provided. It also had been observed that in some continuous concrete slabs cracks had occurred at intervals of 25 to 40 feet; thus the joints were spaced 25 feet on many roads. Gradually joint spacing was increased and, practically, there was found to be no greater number of cracks in the roads where the joints were spaced 50 and 60 feet apart than in those where the joints were 25 feet apart.

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It had also been observed, as concrete pavements became more common and subjected to closer observation, that transverse cracks were frequently the result of original shrinking of the concrete at the time it was laid and that when these cracks formed, if they were filled with plastic material, there was sufficient space provided for any subsequent expansion. This was in accord with a number of laboratory investigations. A number of engineers, therefore, decided to build some concrete roads with no expansion joints. The result has been, after a number of years' service, that these stretches of road, with no expansion joints provided for one or two miles, have proven, on the whole, more satisfactory than those with expansion joints.

Where it is desirable to have transverse cracks occur symmetrically, as is the case in street work, there has been developed a hidden or submerged contraction joint which consists of a single thickness of paper, or thin sheet of metal, which extends through the concrete slab, within an inch of the surface. This form of construction makes it possible to finish the road continuously over the joints, at the same time provides a plane of weakness which will define the crack as it may occur. This has been the practice, particularly in Macon, Georgia, on a number of miles of streets for the past four or five years and has proven entirely successful.

On country and suburban roads, where the symmetry of the occurrence of cracks is not of particular importance, no joints need be provided except at the end of a day's work, and at these places the concrete of one day being placed directly against that of the previous day, making only a contraction joint.

The spacing of the joints, whether they are contraction or expansion joints, is after all but a minor consideration, as there are many miles of roads constructed with joints variously spaced, all of which have given satisfactory traffic service. It is, however, a noticeable fact that the nearer together the transverse joints the more frequent are the longitudinal cracks.

Reinforcing.—The precise function or, perhaps more accurately, the manner in which reinforcement affects the service rendered by concrete roads is by no means clear. Certainly there has been advanced no satisfactory basis on which to make recommendations as to the proper method of reinforcing a concrete road.

As a result of careful observation of something over thirty million square yards of concrete roads, some of which were reinforced and some were not, the conclusion is reached that the reinforcement that has been used, generally averaging about 28

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pounds of metal per 100 square feet of pavement, has not lessened the number of cracks, but has had a marked influence on the width of the cracks that have formed. That is, in the non-reinforced roads a far larger proportion of the cracks have opened sufficiently to become noticeable and require filling with tar or asphalt for proper maintenance. On the reinforced roads a majority of the cracks have not opened up sufficiently to be casually noticeable and have not required any filling.

The cracks which occur are usually transverse or longitudinal. Most transverse cracks are occasioned because of the shrinkage in the concrete due to setting. In this connection it is interesting to note a noticeable difference in the number of transverse cracks that occur in concrete roads laid in warm weather and those laid in the fall, the former having a larger number of cracks.

It is evident that these transverse cracks cannot become very much widened by movement of the concrete slab and if given prompt and proper attention do, as a matter of fact, cause very little or no inconvenience whatever.

Longitudinal cracks are occasioned primarily by unequal movement of the foundation. In general, the cause of this movement is due to variation in the moisture content of the subgrade which may occasion either a slight rise or a slight depression. When a longitudinal crack occurs there is opportunity for it to widen as the two portions of the slab tend to separate; so that transverse reinforcement which will tend to hold the two sections of the slab together, although not sufficient to prevent cracking, performs a function of definite value.

As the object to be attained by reinforcement is chiefly to hold portions of the concrete together where a crack has occurred, particularly to hold the edges of the crack together at the surface, the reinforcement should be placed nearer the top surface than the bottom of the slab. If the slab cracks because of tension in the surface, then the upper edge of the crack or portion exposed to the surface tends to widen, and reinforcement at this point would help hold it together. If a crack occurs because of tension in the lower side of the slab, it will not open up at the surface; therefore, no particular harm has resulted, and the reinforcement being in the upper section of the slab will keep it from opening further. It has thus become a general practice to place the reinforcement near the top of the slab, about 2 inches from the surface.

More exact data are necessary before any definite conclusion can be drawn as to the actual economy of reinforcement. Until such are available, it is probable that the use of reinforcement will, to a great extent, depend upon its cost. A good, practical

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rule to follow in the meantime would be to reinforce those portions of the road where the drainage conditions lead one to expect the greatest disturbance to occur in the subgrade. For example, where the subsoil is sandy or of a gravelly nature, which insures good natural under-drainage conditions, reinforcement would be of the least value, while in cuts through clay hillsides it would be of maximum value. It also should be kept in mind that so far as our present knowledge goes, there is little or no value to be attached to the portion of the reinforcement which is laid longitudinally. Therefore, that type of reinforcement should be used which employs a maximum portion of the metal, transverse of the road.

The tendency has been for an increased use of reinforcement in the construction of concrete roads. Whereas comparatively few concrete pavements were reinforced in the period from 1909 to 1914, of those that were built in the years 1914 to 1916 inclusive, nearly 32 per cent were reinforced.

Finishing

Progress.—The methods of finishing concrete roads have undergone perhaps a greater development than any other one feature in connection with their construction. On the earlier roads it was not realized how important a part the method of finishing played. The result has been that while otherwise of good quality, some of the older concrete roads do not have that even surface which it is especially desirable to have for fast-moving motor traffic.

The ordinary method of finishing a concrete road the width of which does not exceed 20 or 24 feet is to place the concrete between the side forms to about the required thickness, then strike the concrete with a template which is cut to the proper shape or the crown of the road. It was formerly the practice after the template had removed any surplus concrete and the low places had been filled to the proper elevation, to float the surface with wood floats, the workmen being supported by a light bridge spanning the road. The almost inevitable tendency with the float finishing was to cause hollow places in the surface. The workmen in an endeavor to fill up a certain spot in the road would work mortar from one place to another, thus destroying the general evenness of the surface as made by the templates.

Roller and Belt.—A great improvement on the hand-float method of finishing was effected by the use of belts 6 to 10 inches wide which were cut to a length some 2 feet longer than the width of the road. The workmen stand on either side of the road, one at each end of the belt, which is given a seesaw

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motion, the belt resting upon the surface of the concrete. This effectively fills the porous places that may have been left by the template; at the same time there is no tendency to make uneven places in the road. The belt method came into general use during the working season of 1916, although it had been used in a few places some years prior to this.

An even greater improvement in the method of finishing is what is known as the roller method. This method has been in use for some five or six years past, but it did not come into general use until the working season of 1917. The roller method consists of rolling the surface of the concrete, after it has been struck with a template, with a light hollow metal roller weighing about one pound per linear inch, having a diameter of about 10 inches and a length of 6 feet. If the road is comparatively narrow, 18 or 20 feet, the roller is operated by means of a long pole attached to the bail. Where the road is much wider it is more convenient to provide the roller with a continuous or double bail to each side of which is attached a rope, the roller being operated by two workmen, one standing on either side of the road. The roller moves over the freshly laid concrete transversely back and forth, advancing a few inches with each trip across the road.

The roller serves a double purpose. It was used primarily to give an even surface to the concrete laid on wide streets which had not been struck by a template, but merely smoothed with the backs of shovels to approximately the required surface. But the roller accomplishes a far more significant result than this. As it moves over the concrete, it will be noticed that a very large amount of water is squeezed out, the roller acting as a rolling squeegee. After an interval of 10 to 20 minutes, the surface being again rolled, more water is squeezed from the concrete, and, depending upon the temperature of the day and the amount of water with which the concrete was originally mixed, from three to five or six rollings may be made to good advantage. The removing of the excess water makes the resulting concrete stronger, as we have already discussed under the mixing of concrete. Laboratory tests made upon slabs of concrete, some of which were rolled and others wood floated, but otherwise of identical workmanship and materials, showed that the rolled concrete had a cross-breaking strength approximately 20 per cent greater than the wood-floated slab.

In practical work the roller should follow the strikeboard or template just as soon as may be, which will be from 10 to possibly 30 minutes, depending upon weather conditions and the amount of water in the concrete. In cool weather, when the setting of the concrete is somewhat slower, the interval will be

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longer than in warm weather and likewise a longer interval where much water has been used than with stiffer mixtures. Usually concrete is rolled from three to four times at intervals of 15 to 20 minutes. The belt should be used after the roller to give the surface a uniform texture and to remove slight irregularities left by the roller. It is better to use for this purpose two belts; the first to follow immediately the last rolling, giving a full arm movement to the belt. The second belting follows the first as soon as the sheen disappears and is given a shorter arm movement and advanced along the pavement but a few inches with each stroke. The accompanying photograph shows the general progress of the work using the roller and two belts. This method has been found to give not only a better quality of concrete than other hand methods, but is also accomplished at a less cost, so that it has met with a very ready reception on the part of the contractors as well as the engineers.

Finishing Machine.—There have been developed a number of machines for finishing concrete roads. These machines are usually designed to strike off the concrete and give a finished surface with a single operation. The machines have now been perfected to a point where they are practical, and in so far as they permit handling a stiffer concrete than can be done by hand, they are of advantage. They also will produce a surface of greater mechanical perfection than can be generally secured by other methods. But their chief value lies in the fact that they require and can handle a stiffer concrete than is possible otherwise. This means a concrete mixed with less water and of consequently greater strength.

As contracts for longer pieces of road are let contractors will be justified in providing themselves with more complete outfits in all particulars, when we may expect to see finishing machines come into more general use.

Curing

The importance of proper curing of concrete roads has been generally recognized. All specifications require that this feature of the work shall be given due care. In general they usually provide that concrete should be kept moist by covering, as soon after the concrete is laid as possible, with a layer of earth which is kept moistened for a period of ten days to two weeks. Under the most favorable conditions for hardening, the pavement should be kept closed to traffic for fourteen days.

The best method of curing is what is known as "ponding." Curiously enough this method was first used in the arid regions. Small earth dams are made alongside the concrete with frequent

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cross dams; the enclosed spaces being filled with water over the surface of the concrete to a depth of 2 or 3 inches. This method can be advantageously used unless the grades exceed 4 or 5 per cent. The ponding method is shown in the accompanying cut.

Maintenance

The maintenance required on concrete roads divides itself, as on all roads, into two distinct parts: the work which is required to be done on the shoulders, ditches and other drainage structures, and that which is required to be done on the pavement proper. Only the latter feature will be here considered.

Prompt maintenance should be the rule on concrete roads, as with all types of roads. Cracks in concrete roads occasion no inconvenience whatever to traffic, and traffic will not injure the road at such a place if the crack is filled with tar or asphalt and covered with sand. The bituminous material is poured into the track in sufficient quantity just to flush the edges. There have been developed portable outfits mounted on small trucks which make it possible for a crew of two or three men, including the driver of the truck, to operate most efficiently.

Where it is necessary to cut through a concrete pavement for any reason, it can be replaced so that it is almost impossible to tell where the repaired portion is. The only precaution necessary in this work is to use the same kind of aggregates as those composing the pavement; otherwise the repaired portion may develop a slightly different color.

It has been found that the best repairs are made by using a very stiff mixture and ramming the concrete thoroughly into place. The edges of the cut should be shaped so as to be practically vertical for a depth of 2 to 3 inches from the surface. The repaired surface may be covered with planks over which is thrown a layer of moist earth so that the pavement may be immediately used by traffic with but slight inconvenience, in case the cut occurs at such a point or is of such an extent that that portion of the highway cannot be entirely blocked temporarily.

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THE REINFORCED CONCRETE HIGHWAY OF THE FUTURE FOR 30-TON TRUCKS AND HEAVY ORDNANCE

By WM. S. THOMPSON, *Chief Engineer Corrugated Bar Co., Incorporated.*

A road may be defined as a medium of communication or pathway from one point to another over which vehicles can travel. To the mind of the average individual, if he gives the matter any thought at all, this is all the definition necessary satisfactorily to describe a road. If, however, he digs deeper into the subject he finds that fundamentally a road is a structure, in the same sense as is a bridge or a building, and as such is subject to stresses and deformations of one kind or another of which account must be taken if it is successfully to demonstrate its usefulness as a medium of communication.

The Roman highways, of world-wide fame, were built with an eye to the future; they were built to last and they did, and we in this day would do well to emulate the example thus placed before us and give thought to what is to come, for it is safe to say, in general, that the roads we are building today are by no means sufficient for the traffic of the near future. The war opened our eyes to the possibilities in motor-truck transportation and to the function of roads in military operations where volume and weight of traffic is at its maximum. In the war zone all precedent relating to the design and construction of bridges had to be abandoned and new methods employed to meet the traffic conditions. That is the lesson that war taught the bridge engineer. The bridge, however, is but an extremely small though necessary link in a highway system, yet it would be of small avail to strengthen this link were not the highway in all respects equal in capacity to the bridge, and so we return to the consideration of a road as a structure.

To produce a successful structure requires a study of the mechanics surrounding the problem. Too often the concrete road slab is viewed in the light of merely a surface finish, something to protect the subgrade and provide a smooth path for vehicular traffic, while its function as a structural member is overlooked entirely or deliberately ignored because to do the job properly would require more money than the appropria-

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tion allows for a given mileage. Such a policy simply winks at the facts in the case, and as a result money is spent for a faulty construction and in the end more money is spent to patch it up or rebuild along proper lines.

The concrete highways of today have in the majority of instances lived up to the expectations of their advocates. They have sustained successfully not only an ever-increasing volume of traffic, but have withstood the test of heavy loads moving at comparatively high speeds, conditions that have been particularly destructive of several other types of road. It is true that many concrete road slabs have cracked, a weakness, however, which should not be charged against concrete as representing a faulty structural material, but to failure to observe the fundamental principles surrounding the design of concrete structures. That it is a thoroughly reliable structural material needs no demonstration; witness its use in thousands of bridges and buildings throughout the country. What engineer, however, would consider its employment without giving careful attention to its proper reinforcement in regions where tensile stresses exist, for though concrete is thoroughly capable of resisting compressive stress it is "there," so to speak, to only a limited extent when we consider its capacity in tension. So if we expect to eliminate objectionable cracks from concrete pavements this fact must be recognized and steel supplied in proper amount and distribution to meet the deficiency. We must turn from precedent and tradition to logical methods of design based on reliable experimental data if success is to be achieved for the coming concrete road.

As the problem surrounding the design and construction of concrete highways are essentially engineering problems, so upon the engineer will rest the responsibility for securing proper expenditure of the vast sums of money about to become available for road construction and development of the motor transport industry. Unfortunately, we lack much necessary information that would enable us to approach the design of a concrete road slab with some degree of certainty. For instance, there is no information available, of a definite nature, that will permit the engineer to compute with accuracy the bending moments occurring in the slab for various conditions of subgrade, load, impact, etc., yet this is just the sort of information he needs to enable him to design his structure intelligently. Without data he is working in the dark and the resulting structure will be a hodge-podge of guesswork from which successful performance can scarcely be expected and economic waste is a certainty.

Happily relief is in sight through the extremely valuable

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experimental work now being conducted by the U. S. Bureau of Public Roads. Very illuminating data on the question of impact has already been obtained by the bureau and is interestingly set forth in an article by Mr. A. T. Goldbeck, Testing Engineer, Bureau of Public Roads, appearing in *Engineering World* for December 1, 1919, and it is to be hoped that as the testing program for the coming year develops many of the uncertainties surrounding the design of concrete pavements will have been cleared up and the whole matter placed on a scientific basis.

As to exactly what loads the heavy traffic concrete highway will be called upon to carry is problematical but a 30-ton truck or piece of heavy ordnance with a concentration of, say, 20 tons on the rear axle would not seem to be a wild dream, and even greater loads may possibly be realized. For the purpose of illustration let us assume the 30-ton truck having a wheel base length of, say, 20 feet and an out to out width of wheel base of 6¼ feet; the road to be 20 feet wide and to have expansion joints every 30 feet. What is the probable minimum slab thickness and reinforcement that would be required to meet this condition?

Were the slab laid on an unyielding subgrade, the load passing over it would produce no deflection and consequently no steel would be needed to resist bending stresses, but usually the subgrade is in the nature of an elastic medium that permits the slab to deflect under load and as a result bending stresses are induced and reinforcing steel must be supplied to resist them if cracks are to be avoided. Also, according to the position of the load, the bending of the slab may produce tension in either the top or bottom surfaces thus necessitating reinforcement at both points. Particular attention should be directed to this feature for we sometimes see a specification calling for the reinforcement to be placed midway between the two faces of the slab. To the reinforced concrete engineer this appears ridiculous as this mid-point of the slab is one of zero stress under conditions of cross bending, so that any steel placed there can exert no influence toward preventing cracks from forming in either face of the slab, and when the crack has once formed its only function would be to prevent the two pieces of concrete from separating farther.

If, in the problem selected, the slab were supported at definite points, we could readily determine, from the given load and span, the magnitude of the bending moment and shear in the structure and from this information proportion the thickness of concrete and amount of reinforcement required. The conditions, however, are reversed in our case and we must consider the wheels of the truck as representing the points of support and the upward reaction of the subgrade as representing the load. We

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are in the dark, however, regarding the shape and magnitude of the loading diagram produced by the upward reaction of the subgrade; but from tests made by the U. S. Bureau of Public Roads (See paper by E. B. McCormick in *Journal of American Concrete Institute,* January, 1915) on slabs of definite span and width, having concentrated loads applied at the center of the span it was found that the effect of the load was apparent for a distance of 6 to 8 times the slab thickness on either side of the loaded point, the intensity being a maximum immediately under the load and decreasing approximately at the ordinates to a triangle on each side. This is no doubt analogous to the condition existing in a road slab under load and will serve at least as a tentative basis for design for such a slab until further experimental data develops the exact situation.

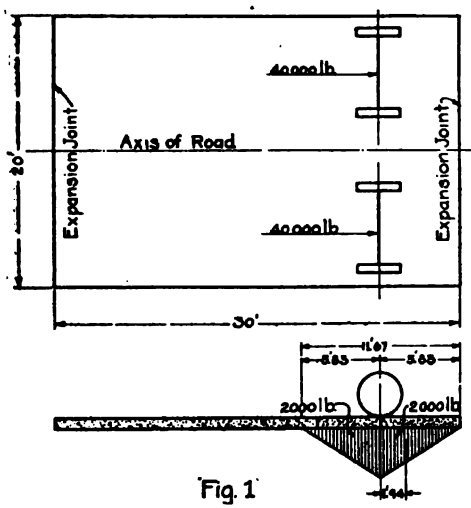


Fig. 1

Assuming a slab thickness of 10 inches and a distribution either side of the load of 7 times the slab thickness gives, for the base of the triangular-shaped loading diagram, 11.67 feet. In Fig. 1 is shown the position of load for maximum bending effect for the bottom of the slab in a longitudinal direction. The load per foot width of slab, $W = \frac{80,000}{20} = 4000$ lbs. and the bending moment, $M = (2000)\ (1.94)\ (12) = 46,000$ inch lb.

To find the bending effect in the top of the slab, in a longitudinal direction, we may consider that portion of it to the left of the wheel load (See Fig. 1) and consider it as a slab fixed at the end under the wheel and at the end where the load is zero, as illustrated in Fig. 2, in which the curvature of the slab is shown greatly exaggerated. For such a condition the moment in the beam at the end of zero load is $M = \frac{wl^2}{30}$ where w is the intensity

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of load under the wheel and for this particular problem is equal to 686 pounds per square foot, and

$$M = \frac{(686)\,(5.83)\,(5.83)\,(12)}{30} = 9300 \text{ inch lbs.}$$

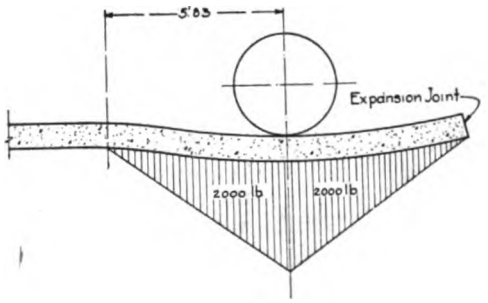


Fig. 2

This it will be noted is but one-fifth of the bending moment in the bottom of the slab longitudinally.

Passing now to the question of the bending effect in a direction transversely of the axis of the road, the position of the load to obtain maximum conditions in this direction, will be that shown in Fig. 3. Considering a strip 1 foot wide under the wheels we have, as before, a load intensity of 686 pounds per square foot assumed to be uniformly distributed, and this 1-foot wide strip becomes a beam supported and loaded in the manner indicated in Fig. 4; the wheels representing the points of support and the reaction of the subgrade, the load with the relative positions reversed in the illustration.

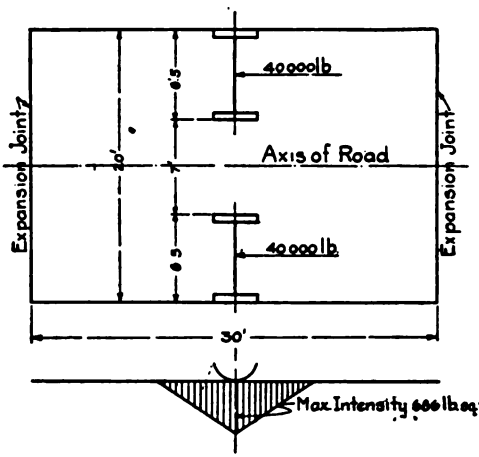


Fig. 3

The maximum transverse bending moment in the bottom of the slab will then be at M_2 or M_3, and in the top of the slab at Mc. The magnitude of these bending moments may be determined by moment at M_2 or M_3 is equal to 45300-inch pounds, and the moment at Mc to 33400-inch pounds.

The bending moments above given are for static load and are as follows when tabulated for the different portions of the slab:

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Bending moment in bottom of slab longitudinally = 46000 in. lbs.
" " " top " " " = 9300 " "
" " " bottom " " transversely = 45300 " "
" " " top " " " = 33400 " "

Assuming a unit stress in the steel reinforcement of 20,000 pounds per square inch, and in the concrete of 800 pounds per square inch, we may compute the thickness of the slab and the amount of steel required to reinforce it. From the tabulated moments we note the maximum to be 46000-inch pounds and for the unit stresses assumed the minimum depth from surface of slab to center of steel is, from the theory of reinforced concrete design,

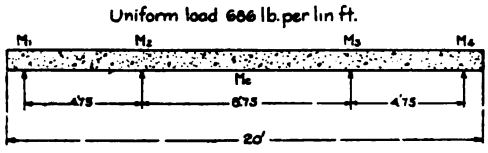
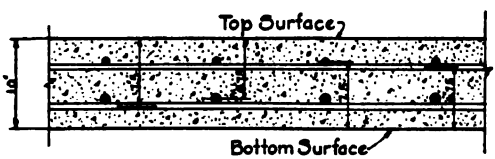


Fig 4

$$d = \sqrt{\frac{46000}{(131.3)\ (12)}} = 5.4 \text{ ins.}$$

This represents the effective depth of the slab to which should be added about 2½ inches for protection of the steel. From practical considerations, however, the minimum total thickness should not be less than 10 inches. In Fig. 5 is shown a longitudinal section of the slab on which are indicated the distances from either top or bottom surfaces to the centers of gravity of the steel areas, and the amount of reinforcement may now be obtained.



LONGITUDINAL SECTION OF SLAB

Fig. 5

We will assume that the distance between the centers of action of the compressive and tensile forces is 7/8d, then for each foot of width,

square ins.

Steel in bottom of slab longitudinally, $A_s = \frac{46000}{(7/8)\ (7.5)\ (20000)} = 0.35$

Steel in top " " $A_s = \frac{9300}{(7/8)\ (6.75)\ (20000} = 0.08$

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		square ins.
Steel in bottom of slab transversely	$A_s = \frac{45{,}300}{(7/8)\ (7.5)\ (20000)} =$	0.35
Steel in top " "	$A_s = \frac{33{,}400}{(7/8)\ (6.75)\ (20000)} =$	0.29
	Total	1.07

Knowing that a square inch of steel one foot long weighs 3.4 pounds, we find the weight of steel per square foot of pavement is (3.4) (1.07) = 3.64 pounds, or for a road 20 feet wide it would require 384,000 pounds of steel per mile. At present day's prices this would represent a cost of about $16,000 per mile of heavy traffic road.

This is somewhat startling to be sure, and further experimental investigation may show that the assumptions made are in error, but nevertheless the analysis points very clearly to the fact that we must revise, to a radical extent, our ideas on what constitutes a proper reinforcement for concrete roads intended for the carriage of heavy loads. Furthermore in the problem considered the static load only has been used in the calculations, and from tests that have been made we know that impact plays an important part in road design and would, therefore, tend to increase rather than diminish the quantity of steel required. Some saving in reinforcement could, of course, be made by thickening the slab, and experiment may show that the service will demand a thicker slab to meet properly the effects of surface wear and impact.

We should approach the question of the heavy traffic road of the future with our eyes open, for now is the time to gather in all of the facts surrounding the problem, when the motor transport industry is in its infancy, and then to apply the knowledge gained to produce a road structure that is as nearly perfect as human ingenuity can make it.

The coming motor truck will scarcely wend its way over the highway with fairy-like tread; rather it will be a lumbering giant, jarring and rumbling along at no snail's pace, and woe betide the weak sisters among the paving slabs it may encounter in its travels, for they shall be no more, and the money, time and effort expended in their building shall have been wasted, but the lesson taught will have come too late.

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BRICK ROADS

By Will P. Blair, Vice-President of the National Paving Brick Manufacturers' Association [1]

Brick pavements have been used on the streets of American cities for many years and the United States Bureau of the Census reports that in 1909 they formed nearly 24 per cent of the entire mileage of paved streets in 158 cities.

In recent years many miles of country highways have been improved with brick, Ohio, Indiana, Pennsylvania and Florida leading in the number of miles and also the number of road sections scattered well over those States. Sections of roads improved with brick are to be found in almost every State in the Union. Perhaps the most notable and also the longest continuous brick-paved section is that of the National Road leading westward from Wheeling, West Virginia, toward Columbus, Ohio, approximately 75 miles.

Some of the early brick pavements gave satisfactory service for many years, but others did not. The unsatisfactory early experience was due in part to the use of unsuitable materials, in part to the improper reconstruction of pavements cut to permit laying pipes, and in part to the defective methods of construction employed, just as was the experience with other types of block pavements. It is not possible to build lasting brick pavements unless the blocks are prevented from settling, which results in holes in the surface; or from tilting over on their bottom side, called "turtling," which results in a rounding of the upper edges of the blocks, called "cobbling." Throughout the long use of vitrified brick for paving streets and roads by various methods of installation and under a great variety of local conditions, climatic and other influences, examples are now afforded out of such experiences to select such types as will meet most advantageously any improvement contemplated. There are always communities as well as persons unwilling to profit by the experience of others, however, and consequently some brick roads have been built of poor materials and by poor methods, with the inevitable unsatisfactory results. Such unfortunate experience was unnecessary then and is unnecessary today; it was largely due to ignorance of the requirements for good work, carelessness, lack of proper supervision, and a desire to cheapen the cost of such roads below the amount needed for proper construction.

[1] From whom complete specifications for the construction of brick roads and streets may be obtained.

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Again, too, without a proper appreciation of local conditions and the ability to meet them there is often included expense wholly unjustifiable.

Paving Bricks

Paving bricks are made from a great variety of shales and fire clays and consequently bricks of equal worth vary considerably in appearance.

In the manufacture of paving brick the raw materials are crushed and ground dry in large revolving pans under heavy rolls, called "mullers." This material is screened to remove pieces of too large size, and is then conveyed to a pug mill. This mud is fed continuously into a brick machine, where it is forced by an auger through a die, whence it emerges as a fairly hard bar of rectangular section which is cut mechanically into bricks. This bar of hard clay may be approximately 3 x 4 inches in section, in which case it is cut about every 8½ inches, forming "end-cut" bricks, or it may be approximately 4 x 8½ inches in section and cut every 3 inches, forming "side-cut" bricks, in either case producing a brick in size 3 x 4 x 8½ inches. These bricks are sometimes submitted to a reshaping process before drying, in which case they are called "re-pressed" bricks, and sometimes they are dried as they are finished by the brick machine, in which case they are called "wire-cut" bricks.

For drying, the bricks are placed on cars which are run very slowly through a long, tunnel-like heater, into which hot dry air is admitted continuously. After remaining on the cars in the tunnel about 24 hours their weight is reduced from 15 to 20 per cent. The bricks are then stacked in kilns in such a way that the heated air circulates freely around them from the time the kiln is first warmed until it is cool enough to permit the withdrawal of the bricks. Great care must be taken in the regulation of the temperature throughout the entire burning process. According to the process of manufacture one side of a paving brick has either two or four lugs, which are small projections from the surface of the bricks. These projections serve to keep the adjacent faces slightly apart when the bricks are forced into contact during the paving operations. These projections extend ⅛ to ¼ inch from the side or face. In one class of side-cut bricks the cutting is done by wires which are moved across the bar of clay so as to produce the lugs needed on one side of the brick. These are called "wire-cut lug" bricks. When the clay column is cut straight through, the brick are termed "wire-cut."

"Hillside" bricks are made for use on grades of 5 per cent or more. They have one or more grooves cut the full length of the

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bricks, along their edges, in the case of bricks to be laid in the usual manner, or two grooves cut transversely in the case of bricks to be laid parallel with the curb. These grooves are about ⅜ inch deep and are intended to prevent slipping of horses or automobiles. Bricks with beveled edges are used for grades, notably on the carriage ramps of the Pennsylvania Terminal in New York, where the travel is very heavy and quite generally on grades exceeding 5 per cent.

Tests of Bricks

The color of the interior of bricks from the same plant gives an indication of their quality. The color of the exterior of the bricks is a less reliable indication of quality, and even interior color is of little or no value in judging the bricks from different plants.

Formerly a number of different laboratory tests of the properties of paving bricks were required, but today reliance is placed mainly on the rattler test in accordance with the Specifications of the American Society for Testing Materials, for Testing Paving Brick. Experience with this test during the past few years has demonstrated its efficiency in securing quality of brick contracted for. A copy of these specifications may be obtained from the National Paving Brick Manufacturers' Association, Cleveland, Ohio.

Some years ago the crushing strength and specific gravity of paving bricks were considered properties which should be specified, but experience has shown that it is unnecessary to do so. The specific gravity of fire-clay bricks averages between 2.1 and 2.25 and that of shale bricks between 2.2 and 2.4. The crushing strength of good paving bricks ranges from 10,000 to 20,000 pounds per square inch, when the test load is applied over the entire top surface of the specimens, and may be higher if only a part of the surface is loaded. This is from five to ten times the probable maximum load on a pavement.

The capacity of a brick to absorb water was formerly considered an important indication of its porosity, and low porosity was held to be essential for strength and good sanitary properties, which were then considered as particular advantages of brick pavements. With the improvements that have been made in the rattler test and the increased knowledge of the slight influence of a wide range in porosity upon the sanitary value of such pavements, the absorption test has lost much of its former favor among road builders. It affords useful information, however, in comparing bricks made under identical conditions and for other research work.

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Curbs

Curbs are required along the sides at the edges of the city streets as a part of the gutter provision for the flow of water and as a wall to support the lawn on sidewalks at its grade elevation. They form a part of the finish which contributes to the tasty appearance of the street.

In the construction of country roads, experience has shown that where monolithic or semimonolithic construction is used, by laying the brick in green mortar or mixtures of sand and cement and filling the joints with a cement filler, curbs are not needed and are a useless expense.

Experience has also demonstrated that curbs are not needed where asphalt fillers are used. The practice of making the curb an integral part of the foundation is more harmful than beneficial. A trough is formed which holds the water, permitting it to subside into every chance crevice and opening in or underneath the pavement, instead of the needful provision for an unimpeded flow from off and away from the pavement.

Experience has further shown that a curb independent of the base and set up against the pavement performs its supposed function with but little effect. The frost raises the curb out of place, or with a moistened condition outside the curb it is easily pushed away, leaving the base without any embankment support whatever.

A gravel, broken stone or slag embankment or shoulder which would be subject to compaction by the occasional overlapping of vehicular wheels has proven a far better protection. A still better protection is a berm penetrated with a bituminous material which would allow readjustment of a possible displacement. Present day travel demands that roadways be paved a much greater width than formerly, and where they are paved of sufficient width to accommodate the traffic in safety it is noted that travel rarely ever "gets off" the paved portion.

The Base

In the construction of brick roads the almost universal practice prevails of filling the interstices with a cement, concrete or bituminous filler. This if properly applied insures an impervious top so that no immediate moisture from rainfall effects in any way the superstructure. Injury if at all must result from the surrounding water, in ditch or in the ground, seeking its level near and underneath the wearing surface.

The magnitude and wide extent of injury resulting from this source is so serious that it would seem that efficient measures

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should be taken to remove such agency. Yet it is the common cause that works injury to every type of road improvement. The expansion of a saturated sub-base from the effects of low temperature will range according to soil and the amount of saturation from 2 to 7 inches. The nature of some soils is such that if saturated with water they act like a fluid. In the one case the force of the frost will crack any overlying structure that is built upon it, and in the other the road is relieved almost entirely of support.

The preliminary preparation for the installation of every artificial superstructure of road construction should be to dispense with the supply of water which renders an unstable condition of the underlying soil. To the extent that this is accomplished will the superstructure remain unimpaired from injury below. If, however, the character of the soil or surrounding situation is such that prompt and efficient drainage is impossible and the superstructure cannot be made to render sufficient support, then an artificial supplement is the only known remedy, and a concrete base is the best known provision for that purpose.

If conditions are hazardous the concrete should be reinforced or it will break up. Increasing the thickness of the slab will not add strength in proportion to the increased cost. The largest proportion of road mileage in this country, however, is susceptible of such drainage that ample support of the wearing surface may be secured by supplementing the soil superstructure with a rolled broken stone, gravel or slag base.

It is readily observed that the grade alignment of gravel and stone roads which are properly paved suffers but little impairment from injury due to superstructure conditions, though possessing but little slab strength. If, therefore, there is added to the construction of a properly prepared road bed a compacted gravel, stone or slag base, the protection of an impervious wearing surface of vitrified brick, the road improvement will be one of such durable and satisfactory character that comparable with its cost the height of economy in road improvement will be attained.

Railroads depend for economy on a resilient base, for the greater the weight and force of shock, the greater the injury to the rigid resistance. Benefiting from this experience, a stable bed of rolled stone is doubtless the most scientific support to a wearing surface. But where a concrete base is used and thought necessary as a supplementary support to the wearing surface and to aid in distributing the load to an area larger than the contact wheel base of the traffic, the resilient advantage may be maintained and the base protected from destruction of the traffic im-

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pact by spreading over the base a slight sand cushion of not exceeding an inch in thickness upon which to lay the brick, and filling the joints with an asphalt filler with a high melting point. The 1-inch sand cushion not only protects the concrete base from the shock of traffic, but is a buffer to the wearing course of brick against the upper thrust of the expansive force from below.

This cushion, together with the elastic nature of an asphalt filler, will also permit the slight readjustment to original placement of any disturbed portions of the wearing surface, brought on by causes which would result in very considerable injury to other characters of construction.

The Cushion or Bedding for Bricks

A review of actual experience will doubtless be the best source from which conclusions may be drawn as to the best practice. In the earlier use and until quite recently a sand cushion was almost universally employed upon which to lay the brick. This cushion was not primarily used so much, as many have stated and supposed, for furnishing a convenient smooth surface and to iron out the inequalities of the surface of the brick, as it was to furnish what the word cushion implies—to afford some relief to the shock of traffic. In spite of what would appear to be an obvious requirement to all road students, an almost universal failure to compact and uniformly consolidate this sand cushion has been the practice covering many years, so that most brick pavements have been laid upon bases of uneven support, with the result that the grade alignment was destroyed the moment traffic was put upon it. About all that was done in preparation of the cushion was to smooth the surface of the sand. By such practice it could not be otherwise than that in the attempt to bring the brick surface the grade alignment the roller would span the places of loose sand and push the sand, where a surplus existed, up into the joints of the brick. Such pavements not only lack uniformity of support, but prevent a complete filling of the joints where either cement or bituminous fillers are used. The result as a whole has been a brick pavement condition greatly to the disadvantage of the brick from the very inception of its use.

In the case of the bituminous-filled pavement the brick surface was made to conform to the uneven sand cushion. Where cement filler was used, even where the mixture was well proportioned and applied uniformly, application to the full depth of the brick was not possible. Little sections where the filler did not, as in many cases, exceed one-half inch, were soon broken down by the traffic. Where a severe expansion strain developed, it was not exerted broad-side against the whole brick but against a thin

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upper edge. Injury in some form could not but be expected. Flaking off thin edges of brick, crushing the frail cement filler, crack, rupture, upheaval, were inevitable.

If a sand cushion is to be employed it must be a uniformly compressed sheet before the brick are laid upon it. A thin sheet, not exceeding an inch, has proven entirely sufficient for resiliency and shock and eliminates much of the hazard mentioned.

The so-called monolithic type has come into considerable use. It is accomplished by laying the brick directly upon the green mortar or upon a bed of sand and cement mixed. In the latter case the mixture is spread dry, but in either case the joints are filled with a cement filler uniting the wearing surface to the base, forming a monolithic structure. If, however, neglect in details necessary to accomplish what the name implies are permitted it is obvious that ill results will proportionately follow. If the base is allowed to partially set where it is attempted to lay the brick in green mortar or the sand and cement are wet down and allowed to stand, and in either case the cement filler is not applied promptly following a green mortar condition, there can be no sufficient adhesion and the monolithic character of the construction is not secured.

It can readily be seen that no cushion is used in the so-called monolithic structure, although this intervening sand and cement is sometimes called a cushion.

Careful students and observers are unanimously agreed that sand cushions should not be employed where the cement fillers are used. Consequently it may be stated that cement fillers are rejected except where monolithic construction is undertaken. The hazard and abuse of the sand cushion here discussed is best avoided by its employment of a thickness not exceeding 1 inch and in connection with an asphalt filler. Experience has shown that a cushion of that thickness is more easily compressed, that it obviously affords an opportunity for but the slightest ultimate depressions and there is less chance of a flow of the sand into the joints. It responds to every function that is possible with a thicker cushion, with none of its faults. It is quite sufficient for adjustment and readjustment of any disturbed condition.

In General

A correct understanding as to the natural agencies which exert injury to roads is a fundamental acquirement. Without such qualification one is scarcely fitted to pass judgment as to what should be done or what should not be done in the building of any road. Provisions must be made in each case to prevent destruction from such causes. Flood, moisture, climatic conditions and

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the varied influences which arise from them must be given proper consideration. It is not too much to say more repairs are due to an utter disregard of these influences and neglect to provide against them than the impairment of roads by the actual traffic upon them. Traffic injury to the brick wearing surface is but slight indeed, unless that surface is first placed at a disadvantage by neglect of the natural causes.

A significant fact that may make what is here stated more impressive is that where proper provision is made and complied with in the construction of brick pavements, covering existing conditions with a proper installation of the pavement, regardless of age or volume of traffic such pavements have not suffered any appreciable wear, many have not been subject to any repair whatever, and others have needed only the slightest repair.

The details necessary to realize the advantages of these suggestions and the information given particularly belong to the specifications, which must differ in part in the improvement of each road. Conditions are found which must be dealt with as they exist. No two road conditions are alike. A universal rule, however, in complying with every specification which is made is that no detail shall be neglected or carelessly executed.



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GRANITE BLOCK PAVEMENT

By Granite Paving Block Manufacturers' Association of the United States, Inc.

Stone blocks have been in use for the formation of roadways since time immemorial. The earlieast known roads were constructed of this type. The road to the Pyramids was constructed, we are told, of solid blocks of stone by King Menes about 3,200 B. C. The Appian Way, a lighter type of stone block roadway, was constructed under Appius Claudius about 312 B. C. The present granite block pavement developed directly from the old cobblestone pavement which has now entirely disappeared from all progressive communities. Cobblestones were easily procured, they were known to be possessed of great durability and the construction of cobblestone roadways was inexpensive. For these reasons they were extensively constructed. The resulting roadways were rough, dirty, noisy and generally unsatisfactory, and the desire for a smoother pavement brought about the use of the cut stone block. At the present time the cobblestone roadway is almost a curiosity, but there are about 60,000,000 square yards of stone block pavement in the United States.

The universal adoption of granite for block pavements is due first, to the resisting power of the granite both to the abrasive action of travel and to the impact of loaded wheels, and second, to an important property possessed by all granite blocks, that of splitting in three planes at right angles to each other so that paving blocks may be easily formed with nearly plane faces and square corners. This latter property, called rift and cleavage, permits the splitting and dressing of the blocks to regular rectangular shapes. The more regular the blocks the thinner the joints and the smoother and more durable the pavement.

Production.—Granite blocks are produced through successive subdivisions on cubical lines until finally the individual block is produced. No fracture results, or is imposed, on any individual block other than that along the dimension lines of the block itself, consequently the final block is in no way shattered as in the manufacture of crushed stone. The work is all done by hand, the larger breaks being made by aid of compressed air drills, shims and wedges following a line which has been traced by a stone chisel on the surface of the stone, for granite has a rift and line of cleavage similar to the grain in wood. It is injurious to the

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paving blocks to be thrown, in loading or unloading, from any great height subjecting them to unnatural strains, to which, in their manufacture, they never have been subjected.

Standard Sizes.—Several different sizes of blocks in common use are described following this paragraph and it should be understood by the engineer or commissioner of highways, desiring to use this material, that any departure from these sizes will not mean any improvement in his construction, but will mean that he will be obliged, on account of the fact that schedules are arranged with granite paving block cutters at certain rates per thousand for cutting the blocks, to pay more for any special cut block deviating from these sizes, with no added advantage to himself along construction lines.

Five-inch Standard Paving Block.—Length, 8 to 12 inches; width, 3½ to 4½ inches; depth, 4¾ to 5¼ inches. This block is the acme of perfection so far as granite paving blocks are concerned. Its length and width and cutting tend to produce the finest, smoothest type of paving. Its size is very favorable for freight shipment, it handles well in the hands of the paver laying the work and it looks well after the job is complete on the street. Not being too long, it lends itself to the crown of the street without breaking the continuity of the curve. Some of the handsomest pavement in the world has been produced in the City of New York with this block.

In connection with trunk line highway construction mentioned this type of block lends itself extremely well.

Four-inch Granite Paving Block.—Length, 7 to 11 inches; width, 4 to 4½ inches; depth, 4 to 4½ inches. This block is very successfully used on a concrete base on medium traffic streets with a 1 to 3, or 1 to 4 dry cement mortar cushion, grouted with a 1 to 1 cement grout or an asphalt mastic.

Resurfacing Size Granite Block.—Length, 7 to 11 inches; width, 3¾ to 4¼ inches; depth, 3½ to 4 inches. This block is used very successfully where shallow depth pavements have been removed, leaving the original concrete base for use beneath this type of pavement, without disturbance of the concrete, necessitating no change in gate boxes, manhole tops, or catch basin frames.

Tests.—Although it is our opinion that proper tests are not in practice today for testing granite blocks, owing to the fact that none of the tests include the joint filler itself in the test, and that we believe that the only practical test of a granite block pavement is an actual service test, still it is well to indicate the usual tests which are placed upon the blocks in a great many of the cities. The usual tests are for impact and abrasion designed to compare

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with the impact of steel tires and horses' shoes and the abrasion of wheels on the pavement.

In the impact test a cylinder is cored out from a block ground on the ends to a flat surface, on an emery wheel running under water, and placed in a machine in which a two-kilogram hammer is dropped, beginning at one centimeter and raising the height of the blow one centimeter at each blow of the hammer until the failure of the test piece occurs. The height of centimeters of the blow at the failure is recorded as the toughness of the material.

A test for abrasion is accomplished through subdividing the block into 50 pieces, weighing 5,000 grams. These pieces are placed in a rattler revolving 30 times to a minute for 10,000 revolutions. The loss of material after the rattler test is completed constitutes the abrasion test or wear.

The following are general specifications governing the construction of the several different types of pavement, using granite block as a wearing surface, preceded by various foundation specifications common to the several different types described:

Drainage.—Drainage of the subgrade to every extent which is practical of course is one of the primary requisites for this or any other type of pavement.

Subgrade.—Any subgrade should be properly compacted by rolling or ramming, so far as is possible, all soft or spongy material removed and the holes filled and rammed to a true uniform subgrade throughout.

Concrete Base.—General concrete specifications of the American Society for Municipal Improvements or any other standard specification may be followed. The cement concrete base should be in any case not less than 4 inches thick and running from that up to any depth deemed sufficient to span over any subgrade settlements, such as ditches and the like. The concrete base in general may be mixed in the proportions of 1 part cement to 3 parts sand and 6 parts crushed stone, although the writer's preference would be 1, 3 and 5, for the reason that if the stone aggregate is not properly graded and the large size stone is used, and possibly the sand be extremely coarse, difficulty will be experienced in getting a full and compact concrete bed for the paving to rest upon, there not being sufficient mortar to flow into the interstices of the crushed stone and form a tight base. Labor being an extremely important feature as far as the cost is concerned on any such proposition, it really will be found cheaper in the end to sacrifice the sixth part of the crushed stone in order to easily produce a compact mass for the foundation without the

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continual expense of labor in working the concrete to fill all the voids occurring in the coarser mix.

Sand or Mortar Cushion.—Sand for this purpose should be clean, sharp and coarse. For the mortar cushion the proportion should be preferably 1 to 3, but not less than 1 part of cement and 4 parts of sand by volume, mixed dry. The cushion course may be dampened slightly, if desired, at the time the paving is laid upon it, but should in no case be made of a "sloppy" consistency; and should not be mixed more than one-half hour ahead of its use under the paving blocks on the bed, and no material should be left over, mixed, at the end of one day's work, and used with the addition of the full amount of cement on the resumption of work. There are several reasons for the incorporation of the cement in the cushion course.

The effect of the mortar cushion course on the pavement is as follows: It subdivides the bearing of the blocks over the subgrade or concrete base upon which it is placed. It creates the monolithic pavement from top to bottom. It unites with the grout of the joints, forming a continuous bond around and under all the paving blocks, and should the blocks have been improperly rammed to a true and full bed in the cushion, the setting of the cement in the mixture retains the particles of sand in the cushion coarse in their original position underneath the blocks, preventing them, through impact of travel and vibration caused by travel on the surface of the roadway, in shifting their position underneath the block, and from shaking, settling and rattling away from underneath the paving block, improperly rammed, leaving it suspended in the air and held only by whatever grout surrounded it.

Laying of the Blocks.—On a properly prepared cushion the blocks should be laid in courses at right angles to the lines of the street, and in a straight line from curb to curb, except in special cases, when they may be laid at such an angle as may be directed by the engineer. The blocks should be laid as closely as possible, each block touching the adjoining one on sides and ends, and in courses of uniform width. All joints should be broken with a lap of at least 3 inches. The blocks should not be laid more than 25 feet in advance of the ramming.

Extreme care should be taken in the laying of the blocks that the common fault is not incurred to which many pavers are prone, that is, the crowding of the grade line. This crowding of the grade line is a habit easily acquired by a paver and tends to produce a pavement in a series of waves, from the fact that as the paver gradually approaches the point to which his grade line is attached he naturally, after crowding the line in the slack, in the center, reduces the crowding as he approaches the point of sup-

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port of the line. Many pavers are apt to lay the blocks high above the manholes, catch basins and the like, causing shock to the pavement after it is open to traffic and consequent damage through the fact that the wheel will drop into the depression caused by the manhole or catch basin frame, and then bump up aginst the surrounding paving, producing a trip-hammer effect greatly detrimental to the paving.

Owing to the fact that the paving blocks vary in depth to a slight degree, a skilled paver will sometimes keep the shallow blocks high and the deep blocks a trifle low as compared to his grade line; in this manner averaging the blocks so that they will run to a truer surface.

Different types of paving hammers are used in different sections. The type of hammer with the narrow or medium width blade (with considerable length from the eye to the end of the blade) by the use of which the paver, after making his bed, hooks one end of the stone and places the stone on its bed, without laying down the hammer, seems to be productive of faster work than the short, shovel-bladed hammer in use in some sections of the country. Those using the short, shovel-bladed hammer invariably lay the hammer down, grasp the block with both hands, placing it on its bed. This may seem a small matter so far as each individual block is concerned, but the loss of time in laying down the hammer and picking it up again amounts to considerable in a day's work. Those using the long-bladed type seem to accomplish more in a day and do it easier.

Ramming.—In the ramming each block should be rammed individually to a solid bearing, there being some little difference in the depth of each individual block as indicated in the specifications of size of blocks. It is absolutely necessary that each individual block shall be rammed to a full bed, and should this cause the block to settle below the final finished grade of the pavement it should be removed with paving tongs, an added amount of cushion material supplied, and the block again rammed to a true and even surface with the rest of the pavement. Rolling does not produce proper results, as it does not properly ram the shallow blocks, but rocks them back and forth on their beds and forces the bedding material up between the blocks, displacing the good grout which should be there instead of the poorer bedding material. The reason why paving tongs are specified is that if the ordinary method of pinch bars is used in removing the low blocks, pressure is brought to bear on the edges of the surrounding blocks already rammed, causing them to rock on the bed in which they were originally rammed and dislocating the surrounding blocks materially.

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The ramming of the blocks is one of the most vital features in the construction of a pavement. This should be done by a man skilled in this particular branch of the craft, who has a true eye, as upon his effort the final finished, true contour of the street depends. Poor ramming can spoil paving laid by the best pavers. Each individual block should be struck squarely in the center, and not rocked back and forth either sideways or endways by successive rappings on either sides or ends. Blocks should be rammed to properly meet gate boxes, manhole tops and catch basins.

The rammers used are of various types in various sections of the country. The type most in use in the New England States is a rammer weighing about 50 pounds, with a handle on the top and one on the side, worked by one man. The bow type of rammer used in the vicinity of New York City and throughout a number of other districts in the country is also a one-man rammer, with a bowed handle springing from opposite sides of the rammer and curving around the top of the rammer for a hand-hold at that point. This is a lighter rammer, of about 35 pounds. In the Central West a large two-man rammer is used, the bottom surface of which covers more than the area of one block.

Cement Grout.—Through comprehensive study of many pieces of pavement laid for varying periods of years, up to 20 years and over, it is the writer's opinion that the best wearing grout produced has been that in proportion of 1 part cement to 1 part of sand. This grout makes a dense mixture which conforms more nearly than any of the others to the wearing qualities of the stone it surrounds, and adheres more closely to its surfaces.

The methods of mixing grout in common use are by machine and by hand, of which the machine mixing is by far the more preferable, owing to the fact that a machine continually agitates the grout up to the time of its discharge onto the pavement. By hand work it is almost impossible to keep the grout sufficiently agitated so that the sand will not settle and separate from the cement. This is true in a great measure as the sand increases in coarseness, and still it is not wise to use too fine a sand, as good results are not obtained with sand of this nature. The best sand, particularly for hand mixing, seems to be a sand of nearly uniform composition and one which will all pass a 20-mesh screen.

There are different types of boxes used in the hand mixing, some having legs of unequal length, so that the grout will be thrown to one low corner; the material, after mixing, being either dumped directly out of the box onto the pavement and then broomed into the joints, or taken out of the mixing box by scoop shovels and deposited on the work. Taking the material from

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the box with scoop shovels has always seemed a considerable waste of time. The idea is that there will be no chance of settlement of the sand, the entire box of material being agitated continually while it is being scooped up.

The most practical box mixer is one resting directly on the pavement, having a gate in the end which is lifted up, after the grout has been properly agitated and mixed, the entire mass being then drawn out onto the pavement by the mixing hoes which have been used to agitate the grout.

The machine mixer is much the better proposition, the material being constantly agitated, but in using a machine mixer great care should be taken not to spill unmixed materials on the pavement and into the joints while getting them into the machine, and also that materials shall not be dropped or shaken out of the machine on the pavement or into the joints during the mixing process. When the machine is washed out at the end of the day's work the washing from the machine should not be deposited on the pavement.

The grout when applied should be of a consistency which will readily flow throughout the joints of the paving blocks, but which will not be so thin that the cement separates from the sand and flows away in the gutter lines. There is some shrinkage in the setting of the cement grout. This should be taken care of by continuous brooming operations until such time as no further perceptible settlement occurs in the joints, at which time all excess grout should be removed from the top of the paving blocks and the joints left absolutely flush from the top of the blocks, care being taken that they are not broomed out below the surface of the blocks by too vigorous brushing. The best results are being obtained by a final finished brooming with an ordinary bristle house broom, which leaves a smooth, even surfce without raking out the joints.

In the matter of sand for the grouting, too much care cannot be taken to avoid detrimental foreign materials, particularly loam and clay, which if they occur to any extent in the sand will kill the effect of the cement, producing a chalky, powdery grout with no strength after drying out. A rough and ready test of sand can be easily made by an empty bottle, a handful of sand and a little water. After thoroughly shaking the sand and water together, the contents of the bottle after settling at the end of a short period will show successive layers of fine material, the loam and clay showing at the top. Under no circumstances should the sand show more than 10 per cent of loam or clay, and if sand showing less than 5 per cent this sand should be preferred.

It was the custom at one time, in advance of the application of

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the grout and previous to the ramming of the blocks, to incorporate in the joints a varying amount of peastone. This is an extremely dangerous practice to follow, and if it is absolutely desired to use peastone, the peastone should be wet and thrown into the grout as it comes from the machine or mixing box, and broomed into the joints with the grout. This practice of incorporating peastone in the joints led up, more readily than any other feature in the paving construction, to improper results. Dishonest contractors were prone to fill their joints nearly flush with the peastone, the grout on reaching the peastone never went below that point and very poor paving results were produced.

Another distressing feature oftentimes produced by either leaving too much sand in the bottom of the joints or by this malpractice with peastone, is that owing to the two factors of expansion and contraction, and to the fact that the block is not rigidly held around the bottom, only a shallow collar of cement grout surrounding the top side surfaces of the block, the impact of travel striking upon the top of the block kicks the bottom to either one side or the other, splitting the top of the block off in a similar manner to the successive layers of an onion. From this particular feature many times engineers and others interested have claimed that the paving blocks were "soft," but no instance has ever been cited where blocks from the same quarry, laid in a sand joint, have ever become broken. Blocks laid with a sand joint or soft filler will cobble on the edges on the top, forming the turtleback effect, but will not break up.

Sometimes if the paving blocks are dirty, or have a film of oil, the grout will not obtain a proper hold on the sides and difficulty will be experienced through their letting go. When the grout once "lets go," no further sustaining power can be expected from it, and the only possible repair is a complete replacement with new grout in the joints.

Barriers.—In connection with the cement grouted paving, too much care cannot be taken in regard to protecting newly grouted work. Should the bond between the grout and the block become broken it never will mend. Proper barriers should be erected which will keep traffic from going on the fresh road work and these should also carry warning signs of sufficient emphasis to impress upon the minds of those approaching such work the damage which they are about to inflict upon the work if they travel over it. A watchman at night is an absolute necessity wherever there is any question of travel entering upon the work.

Protection in Freezing Weather.—Protection in cases where work has to be done in freezing weather can be best accomplished by the use of fine sawdust, preferably pine, as oak or chestnut

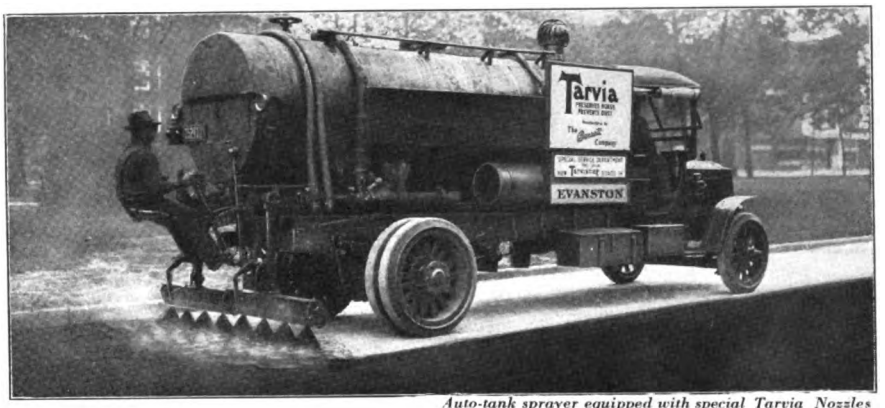
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would be apt to stain the pavement temporarily, leaving a very disagreeable looking piece of work, but otherwise not harming it in any way. It will be found that a thin layer of sawdust is a very efficient protection against severe cold. This material is light, easily handled and spreads readily over the surface of the pavement, and if necessary can be covered against rain by rolling out tarred felt over the top. It is very much more effective than hay, straw or marsh grass and will cover much easier.

Grooving on Hillsides.—Where the cement grout is used on hillsides and steep inclines, in order to provide a toehold for horses, the grout in the joint is sometimes raked out for about ½ inch in depth with a tool resembling an ordinary poker, or by a stiff brooming. But owing to the fact that ordinarily no difficulty is experienced in this manner until about five years after it is constructed, it is better practice, although a little more expensive, to wait until such time as difficulty is experienced, and then with a tool similar to a pean hammer, or else with compressed air tools, cut channels at each joint, making the proper grooving for toehold for horses. In this manner a much better riding surface is obtained than if the joints are raked out or broomed out at the start.

Bituminous Mastic Grouted Pavement.—In some of the most densely populated cities of the country, where it is often necessary to make frequent openings in the pavement, which necessitates easy removal of the material where traffic conditions are such that it is not practical to close the street for any longer period than is absolutely necessary and where it is desired to use the material on hillsides, giving toehold for horses, grouting with bituminous mastic filler is sometimes a great advantage.

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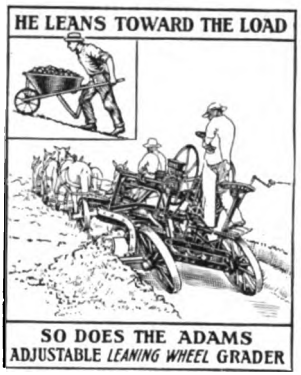
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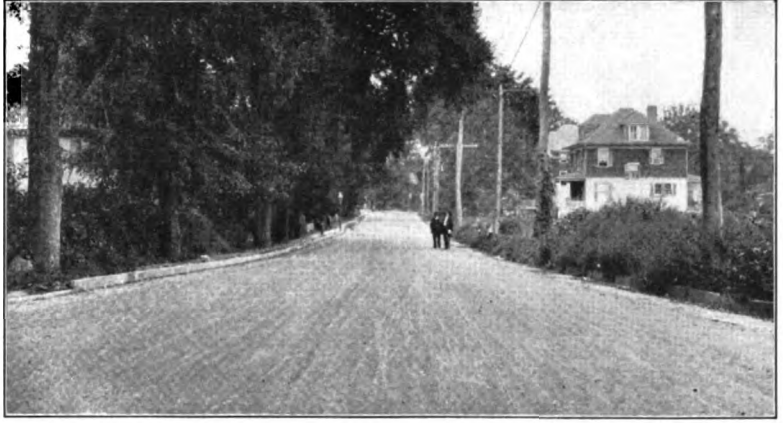
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PART III

Miscellaneous Information and Tables



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OFFICIAL MANUAL OF

MOTOR CAR CAMPING

By

A. L. WESTGARD
Field Representative

Published by

AMERICAN AUTOMOBILE ASSOCIATION

Riggs Building, Washington, D. C.
501 Fifth Ave., New York

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HIGHWAY BONDS[1]

Before a community invests its money in improved roads it is important that plans be made for the ultimate development of a complete system fully adequate to serve its needs most economically. The making of such plans and the selection of the particular road or roads to be improved should be based on sound business principles. Careful consideration should be given to the traffic area which the contemplated improvements are to serve; the present and probable future traffic in ton-miles per annum; the estimated cost of hauling per ton-mile at present and what it probably will be reduced by the improvement; the roads which should be improved first; the approximate cost of the improvement as borne out by the surveys and estimates made by a competent highway engineer; the probable effects of the improvement on farm values, school consolidation and attendance, community betterment and rural delivery of the mails; whether the work can be carried on by direct taxation or whether it is desirable to resort to credit; and if borrowing is necessary, the best and most economical method of financing.

As a high standard of public credit is an asset of great value, every community should conduct public business upon sound financial principles. Bond issues ought to be resorted to only when they cannot be avoided. If a county, township or district is able to levy a sufficient tax to improve all of the roads required in a reasonable length of time without imposing too great a burden on the taxpayers, it should by all means adopt this course. It is also axiomatic that maintenance charges for roads and other current expenses should always be met from the proceeds of an annual tax levy.

Comprehensive study of the community's road problems should make possible a wise decision as to the character and extent of the needed improvement. If the people deem it advisable to issue bonds and distribute the burden over a period of years, then they should determine with careful forethought what kind of bonds should be issued, whether long or short term, whether sinking-fund or serial bonds, and what taxes should be imposed to extinguish the debt.

The life or term of a bond issue should be determined not only by the character of the improvement to be financed, but also by the ability of the county, township or district to dispose of the debt as quickly as possible without imposing too great a burden

[1] Revised by The National City Company, New York.

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upon the taxpayers. The indebtedness should be liquidated at a rate at least equivalent to the depreciation of the improvements thus financed. The payments should be so distributed over a period of years as to avoid the two extremes of excessive or confiscatory levies on the one hand to pay off the debt too quickly and the extension on the other hand of the debt beyond the life of the utility, in order to obtain a low annual tax rate. Sudden and rapid changes of tax rates are to be avoided.

Recognizing the soundness of the principle of limiting the term of such bonds to the life of the improvement, New Jersey and Delaware have expressly imposed such limitations by statute. In some other States the maximum term of public road bonds has been limited to 15 years, even though the roads constructed are the most permanent and durable that is possible to build.

The New Jersey law may, perhaps, be cited as a model illustration of the principle. This law limits the term of public road bonds as follows: For stone, concrete and iron bridges, 30 years; for roads and streets built of concrete 6 inches thick or of block of any material or sheet asphalt laid on concrete foundation, 20 years; for bituminous concrete construction, 15 years; for water-bound macadam, penetration method, 10 years; and for gravel, 5 years.

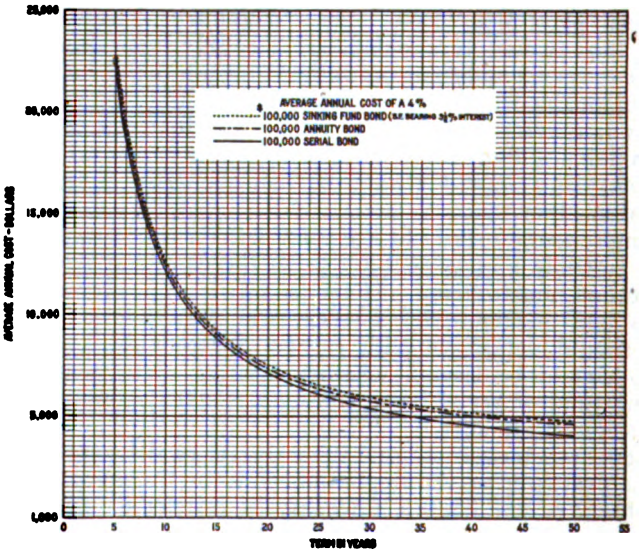


Fig. 1. Little advantage is gained through bonds running more than 25 years

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Many road bonds are issued for terms of 30 years and over to obtain a low annual charge for interest and principal. Very little advantage, as is shown graphically in Figure 1, is to be gained by fixing the term of the bond longer than 25 or 30 years. The cases are probably not numerous where even a much shorter term would necessitate an annual tax levy which would be considered excessive. It is obvious that the character of the improvement will sometimes make the shorter term issues more or less imperative, either on general principles or to comply with statutory requirements.

Corollary to the above principles is adequate provision for maintenance of the improvement during its life. The importance of maintenance is so great that statutes authorizing bond issues for construction should require, as part of the stipulations under which the bonds are issued, an adequate financial provision for the upkeep of roads during the term of the bonds. This insures a more complete statement of the financial obligations of a bond issue before taxpayers vote on the issue. Maintenance provisions will care for depreciation, but not for obsolescence which must be considered in fixing the terms of bonds for such improvements as bridges.

Theoretical discussion of the types of bonds suitable for road improvement financing usually includes sinking-fund, annuity and serial bonds. Practically, however, the annuity bond serves a purpose similar to the serial bond, costs slightly more, and has little favor either among bond dealers or the investing public. These considerations are deemed so important that the further discussion of this type has been omitted.

Under the sinking-fund plan, none of the bonds issued are retirable until the end of a definite period and the entire sum

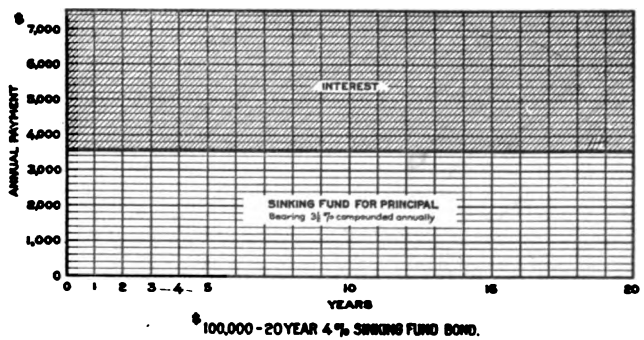


Fig. 2. Sinking fund bonds bear interest on full sum for whole life

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raised bears interest for the entire life of the bond. The county or municipality pays interest on the money so borrowed and in addition sets aside each year, as a sinking fund, an amount which invested at compound interest will be theoretically sufficient to retire all the bonds when they become due. The rate of interest usually compounded on the sinking fund is low in comparison with the interest paid on the bonds.

The method of disposing of a 20-year sinking-fund bond is shown graphically in Figure 2.

Under the serial plan a certain amount of the bonds is retired each year, the interest on the remaining amount outstanding is paid and the bonds retired cease to be an interest charge on the community. The straight serial method would require the heaviest payments for interest and retirement of principal in the early years of the term issue, often before the improvement is fully completed or before it has yielded the community any return. To meet these conditions which frequently arise in road districts, the use of the deferred serial bond has become common. With such a modified type no principal is retired until a certain period, usually five years, has elapsed. During this period interest is paid but nothing more. Thereafter the principal is retired by uniform amounts and the interest charges are met just as is the case of straight serial bonds having a term shorter by five years, or whatever is the deferred period. In this way the road district need not pay anything but interest until the improvements have begun to yield a return.

The straight serial method of payment is graphically shown in Figure 3.

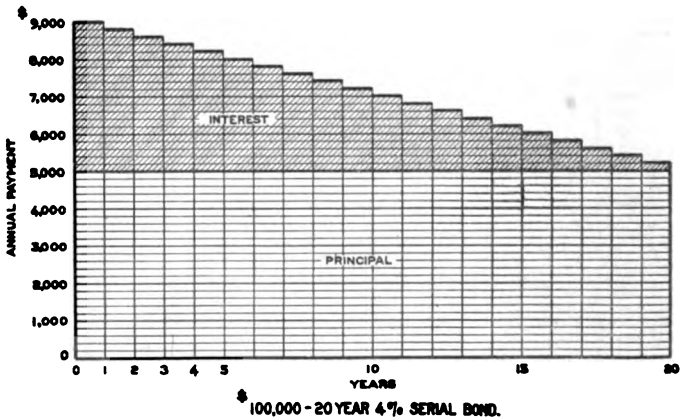


Fig. 3. Serial bonds lessen interest payments

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For road improvements the serial bond is preeminently the most desirable type. The reasons for its special desirability may be briefly stated:

(a) The serial bond minimizes the dangers involved in the administration of a public debt. The serial bond requires annually a specified payment of both principal and interest direct to the bondholder. Both principal and interest must be met out of the annual tax levy. If the principal payment required is not met, there is a public default and community credit is seriously injured, if not ruined. The serial bond makes absolutely certain gradual retirement of the public debt.

Under the sinking-fund plan specified payments for retirement of principal must be made to a fund, custody of which is usually

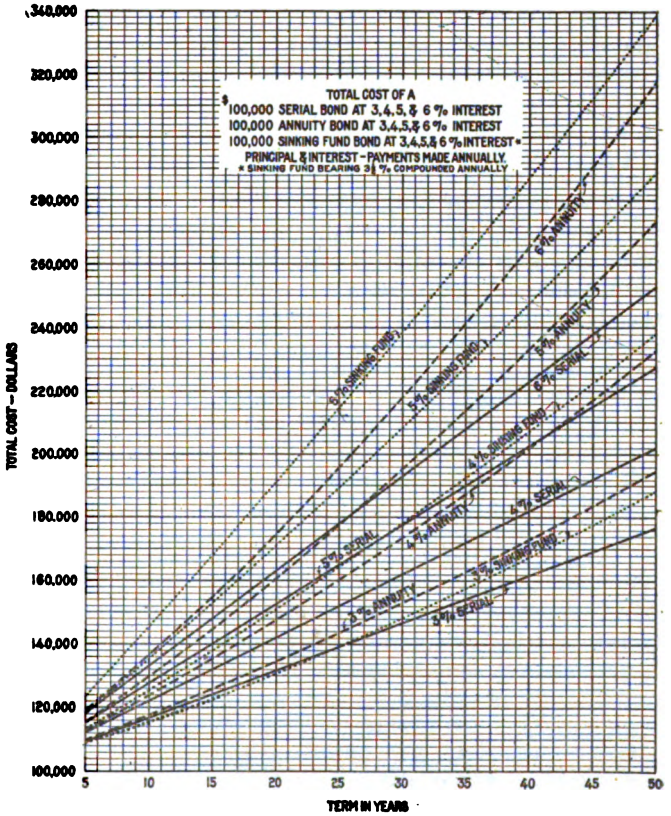


Fig. 4. Relative cost of various bond types

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vested in public officials, until maturity of the debt. Furthermore, the sinking fund must be administered so as to earn compound interest. Unfortunately the financial methods of public officials do not always remain above criticism and it often happens that the annual payment into the sinking fund is forgotten or neglected, no matter how much such contingencies may have been legally safeguarded. Sometimes the money accumulated in the sinking fund is diverted from its purpose. Such departures from sound finance result in lack of money to pay off the bonds when they become due, as agreed, and it then becomes necessary to issue a new series of bonds to carry the indebtedness. The history of the administration and use of municipal sinking funds affords abundant testimony of its dangers. Generally, for most minor civil districts, it may be said to be an antiquated and undesirable fiscal method Until a few years ago sinking-fund bonds were almost universally used. Realizing the economy of serial issues, about 10 states now require serial issues for road improvement issues.

(b) The serial bond is the cheapest form of bond financing. Figure 4 presents the relative cost of the different types of bonds graphically and Table I presents the actual cost comparison between sinking-fund and serial bonds.

(c) Undoubtedly the serial bond maturing within the life of the improvement is the most popular bond for private investors and institutions. A great many investors will not buy a bond maturing in more than 10 years. Serial bonds are attractive because they give the investor an opportunity to buy bonds which will meet practically all his requirements as to length of time of his investments. For instance, a man may have $4,000 or $5,000 in the bank at a low rate of interest and wants to build or buy a house when he accumulates a given sum, say in about 6 years. He is the buyer of a 6-year serial bond. The same may be true in any number of cases not only with private investors, but also institutions. When money rates are low, banks are heavy buyers of short term maturities, say, 1, 2 or 3-year bonds. When money rates are high and as a consequence, bond prices low, the long term bond appeals to the investor. Generally, serial issues enable investors to put out their funds in a more satisfactory manner. The dealer can sell them more readily and may, consequently, be able to reduce his bid slightly.

The management of a bond issue requires attention to all the requirements of the laws governing such matters and a knowledge of the conditions which affect the value of bonds. Every step which the law requires to be taken in connection with such bonds must not only be taken properly but recorded fully and clearly. As

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TABLE I

Comparative Cost—Sinking Fund and Serial Bonds

Average annual cost of a $100,000 sinking-fund bond bearing 3, 4, 5 or 6 per cent interest, with sinking fund drawing 3½ per cent interest, and bonds maturing at different periods from 5 to 50 years.

Term in Years	3%	4%	5%	6%
5	$21,648	$22,648	$23,648	$24,648
10	11,524	12,524	13,524	14,524
15	8,183	9,183	10,183	11,183
20	6,536	7,536	8,536	9,536
25	5,567	6,567	7,567	8,567
30	4,937	5,937	6,937	7,937
35	4,500	5,500	6,500	7,500
40	4,183	5,183	6,183	7,183
45	3,945	4,945	5,945	6,945
50	3,763	4,763	5,763	6,763

TABLE II

Average annual cost of a $100,000 serial bond bearing 3, 4, 5 or 6 per cent interest, and maturing at different periods from 5 to 50 years.

Term in Years	3%	4%	5%	6%
5	$21,800	$22,400	$23,000	$23,600
10	11,650	12,200	12,750	13,300
15	8,267	8,800	9,333	9,866
20	6,575	7,100	7,625	8,150
25	5,560	6,080	6,600	7,120
30	4,883	5,400	5,917	6,434
35	4,400	4,914	5,429	5,943
40	4,037	4,550	5,063	5,576
45	3,756	4,267	4,778	5,289
50	3,530	4,040	4,550	5,060

soon as the voters authorize the issue, a statement of the fact should be drawn up, showing also the area, population and assessed valuation of the district, the value of its agricultural and industrial products, its material resources and the extent of their development, the banking and transportation facilities serving it, the existing indebtedness of the district, the condition and number of the schools, and all other information which will indicate the resources and character of the community that has decided to borrow the money. This information should be sent to banking

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TABLE III

Total Cost of Sinking Fund Bond

Total cost of a $100,000 sinking-fund bond bearing 3, 4, 5 or 6 per cent interest, with sinking-fund drawing 3½, and maturing at different periods from 5 to 50 years.

Term in Years	3%	4%	5%	6%
5	$108,241	$113,241	$118,241	$123,241
10	115,241	125,241	135,241	145,241
15	122,738	137,738	152,738	167,738
20	130,722	150,722	170,722	190,722
25	139,185	164,185	189,185	214,185
30	148,114	178,114	208,114	238,114
35	157,494	192,494	227,494	262,494
40	167,309	207,309	247,309	287,309
45	177,540	222,540	267,540	312,540
50	188,169	238,169	288,169	338,169

TABLE IV

Total Cost of Serial Bond

Total cost of a $100,000 serial bond bearing 3, 4, 5 or 6 per cent interest and maturing at different periods from 5 to 50 years.

Term in Years	3%	4%	5%	6%
5	$109,000	$112,000	$115,000	$118,000
10	116,500	122,000	127,500	133,000
15	124,000	132,000	140,000	148,000
20	131,500	142,000	152,500	163,000
25	139,000	152,000	165,000	178,000
30	146,500	162,000	177,500	193,000
35	154,000	172,000	190,000	208,000
40	161,500	182,000	202,500	223,000
45	169,000	192,000	215,000	238,000
50	176,500	202,000	227,500	253,000

houses and insurance companies making a specialty of purchasing public bonds and, if the issue is a large one, it should be advertised in financial journals. There should be ample time between the publication of these notices and the sale of the bonds for purchasers to make a full investigation of them.

[1] Private sales of bonds for public works should be discour-

[1] This and the next paragraph were prepared by Baker, Watts & Company.

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aged, all sales of bonds should be publicly advertised, and bidders should be invited to submit sealed bids on or before a certain date. The bonds should be sold to the highest responsible bidder who complies with all of the terms and conditions of the sale. The city or county should reserve the right to reject any or all of the bids, as a protection against any effort to pool bids and purchase the bonds at a price considerably less than their value.

Some cities and counties engage competent attorneys, familiar with the preparation of the legal papers pertaining to bond issues, to examine the records prior to the sale and prepare all necessary form. The city or county assumes the expense for all such work and furnishes the successful bidder with the approving opinion of the counsel thus engaged and with the executed bonds. Some cities and counties go even further by providing uniform proposal blanks for the bonds and refusing to accept bids not made on such blanks. The advantage of these provisions is that the seller knows he is offering a legally and validly issued bond, the buyer has the same assurance, and the value of the issue is certainly enhanced thereby. The seller is undoubtedly reimbursed for the expense incurred in such preparatory work by the price he receives for the bonds.



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SUMMARY OF STATE AND COUNTY HIGHWAY BOND ISSUES, AS OF DECEMBER 1, 1919

This list, compiled by the Portland Cement Association, includes only those bond issues authorized since January 1, 1919, with a few exceptions (both State and county), which were authorized prior to 1919, but under which very little or no expenditure has been made to date.

The date of election or authorization is noted when known. When the date is not known or has not yet been set, there is no notation made.

	Proposed	Date of Election	Authorized	Date Authorized
ALABAMA				
State			$ 25,000,000	Feb., 1920
Jefferson county			5,000,000	
Total			$ 30,000,000	
ARIZONA				
Cochise county	$ 1,200,000			
Coconino county	150,000			
Gila county	300,000			
Graham county	100,000			
Greenlee county			$ 200,000	
Maricopa county			4,000,000	May 17, 1919
Mohave county	300,000		200,000	
Navajo county			300,000	
Pima county			1,500,000	Sept. 2, 1919
Pinal county			1,000,000	Sept. 16, 1919
Yavapai county	5,000,000			
Yuma county			1,200,000	Oct. 27, 1919
Totals	$ 7,050,000		$ 8,400,000	
ARKANSAS				
State	$ 15,000,000			
Cross county	300,000		$ 400,000	
Union county			2,000,000	June, 1919
Totals	$ 15,300,000		$ 2,400,000	
CALIFORNIA				
State			$ 40,000,000	July 1, 1919
Butte county	$ 1,814,000			
Contra Costa county			2,600,000	July 22, 1919
El Dorado county, Marshall Boulevard Dist.	150,000			
Fresno county			4,800,000	May 6, 1919
Imperial county	1,500,000		1,500,000	July 1, 1919
Los Angeles county			4,800,000	
Marin county	1,000,000			
Merced			1,250,000	
Modoc county			400,000	July 1, 1919
Napa county			500,000	
Orange county	2,000,000			
San Diego county			2,300,000	Nov. 13, 1915
San Francisco county			924,000	
San Luis Obispo county	1,500,000			
Santa Barbara county	400,000			
Santa Cruz county			924,000	June 10, 1919
Sonoma county			1,640,000	
Sutter county			810,000	Aug. 28, 1919
Tehama county			607,000	
Trinity county	35,000			

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	Proposed	Date of Election	Authorized	Date of Authorized
ntinued				
			$ 580,000	Aug. 26, 1919
			1,000,000	Aug. 26, 1919
	$ 8,399,000		$ 64,635,000	
	$ 5,000,000	Nov., 1920		
			$ 500,000	
	$ 10,000,000			
			$ 400,000	June, 1919
			175,000	May, 1919
	750,000	Nov. 25, 1919		
			390,000	April 22, 1919
			100,000	
	600,000	Oct. 14, 1919		
			450,000	
	$ 11,350,000		$ 1,515,000	
	$ 100,000			
			$ 75,000	
	100,000			
	400,000			
			500,000	
			700,000	
			500,000	
	400,000			
			100,000	June, 1919
			2,250,000	June, 1919
			250,000	June 11, 1919
	600,000			
	350,000			
			500,000	
			250,000	June 30, 1919
			480,000	
			400,000	
	75,000			
			60,000	
			750,000	Aug. 20, 1919
	400,000			
			400,000	May 29, 1919
	160,000	Sept. 10, 1919		
			200,000	
			40,000	
	140,000			
	960,000			
	100,000			
			350,000	
			250,000	June, 1919
			600,000	
	200,000			
	200,000			
	200,000			
			100,000	
			500,000	
			500,000	May 28, 1919
			75,000	
			400,000	July 3, 1919
			325,000	
			100,000	
	750,000			
			250,000	
			200,000	

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	Proposed	Date of Election	Authorized	Date of Authorized
GEORGIA—Continued				
Richmond county	$ 700,000			
Spalding county			$ 350,000	
Terrell county	350,000			
Sumter county			500,000	
Thomas county			700,000	April 29, 1919
Tift county			300,000	May, 1919
Towns county			100,000	
Troupe county			500,000	
Union county			60,000	
Walton county			200,000	
Ware county			630,000	Aug. 22, 1919
Wayne county	350,000			
White county			100,000	
Wilkes county			300,000	
Worth county			400,000	June 25, 1919
Totals	$ 46,235,000		$ 15,245,000	
IDAHO				
State	$ 2,000,000	Nov., 1920		
Ada county	1,000,000		$ 500,000	
Bingham county			600,000	April 12, 1919
Blaine county	100,000			
Bonneville county			500,000	
Butte county			60,000	
Canyon county, Golden Gate District	100,000			
Nampa district			500,000	
Caribou county	100,000			
Cassia county, Burley District			300,000	Sept. 23, 1919
Fremont county			400,000	June 3, 1919
Gem county	200,000			
Idaho county			175,000	
Jefferson county			200,000	
Latah county			1,125,000	
Lewis county, Evergreen Highway District			90,000	
Lincoln county			320,000	July 8, 1919
Madison county	125,000			
Minidoke county			200,000	
Nez Perce county	400,000	Oct. 7, 1919	28,000	
Oneida			250,000	May 13, 1919
Payette county	375,000			
Power county District No. 1	150,000			
Burley District			300,000	
Rupert Highway District	195,000			
Shoshone county, Clarkia District			175,000	Aug. 23, 1919
Teton county			100,000	
Twin Falls county			1,250,000	
Filer District	360,000			
Washington county			300,000	Sept. 14, 1919
Totals	$ 5,105,000		$ 7,373,000	
ILLINOIS				
State			$ 60,000,000	Nov. 5, 1918
Carroll county	750,000			
Cook county			5,000,000	Nov. 4, 1919
Douglas county	62,000		40,000	
Ford county	748,000			
Franklin county	500,000			
Grundy county	600,000		715,845	April 2, 1919
Iroquois county			200,000	
Kane county			20,000	
Lake county			1,040,000	
Livingston county			120,000	

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	Proposed	Date of Election	Authorized	Date Authorized
ILLINOIS—Continued				
Ogle county			$ 60,000	
Peoria county	$ 1,700,000	April, 1920		
Rock Island county	1,000,000			
St. Clair county			1,500,000	
Stephenson county	850,000			
Vermilion county				
Middlefork Twp.			60,000	
Oakwood county			60,000	
Whiteside county				
Tampizo Twp.			25,000	
Will county				
Peotone Twp.			22,000	
Totals	$ 6,210,000		$ 68,862,845	
IOWA				
Blackhawk county			$ 1,500,000	June 5, 1919
Cerro Gordo county			750,000	June 23, 1919
Clay county			800,000	July 22, 1919
Clinton county			1,800,000	Sept. 2, 1919
Floyd county			1,000,000	July 22, 1919
Greene county			1,000,000	July 22, 1919
Hancock county			1,000,000	Aug. 4, 1919
Johnson county	$ 1,500,000			
Kossuth county			1,500,000	July 22, 1919
Lyon county			1,125,000	
O'Brien county			1,500,000	June 17, 1919
Polk county			2,000,000	June 30, 1919
Pottawattamie county	3,000,000	Sept., 1919		
Scott county			2,000,000	June 14, 1919
Woodbury county			2,500,000	July 7, 1919
Totals	$ 4,500,000		$ 18,475,000	
KANSAS				
State	$ 60,000,000	Nov., 1920		
Hamilton county			$ 50,000	July 2, 1919
KENTUCKY				
Caldwell county			$ 300,000	
Carroll county			150,000	
Clay county			300,000	
Floyd county	$ 200,000	Nov. 1919		
Pike county			750,000	
Johnson county			200,000	
Lyons	80,000			
Totals	$ 280,000		$ 1,700,000	
LOUISIANA				
Beauregard Parish				
Ward 3			$ 150,000	
Ward 6			100,000	
Bienville Parish			1,000,000	
Caldwell Parish			500,000	May 20, 1919
Cameron Parish			390,000	April 1, 1919
Catahoula Parish	$ 500,000			
Claiborne Parish	250,000			
Franklin Parish			750,000	
Jackson Parish			500,000	
Jefferson Parish			150,000	
Jefferson Davis Parish			150,000	
Livingston Parish			180,000	
Livingston county				
District No. 2	110,000	Oct. 18, 1919		
District No. 3	270,000	Oct. 18, 1919		
Rapides Parish	2,000,000			
Richland Parish			1,000,000	
St. Mary Parish			125,000	

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	Proposed	Date of Election	Authorized	Date of Authorized
LOUISIANA—Continued				
Tensas Parish			$ 750,000	
Terrebonne Parish			105,000	
Totals	$ 3,130,000		$ 5,850,000	
MAINE				
State			$ 8,000,000	
MICHIGAN				
State			$ 50,000,000	April 7, 1919
Charlevoix county	$ 50,000		300,000	
Delta county				
Emmett county	400,000	Oct. 6, 1919		
Iron county	700,000			
Jackson county			1,400,000	April 7, 1919
Leelanau county			200,000	
Livingston	600,000			
Menominee county			400,000	
Ottawa county	500,000			
St. Joseph	250,000			
Wexford county	200,000			
Totals	$ 2,700,000		$ 52,300,000	
MINNESOTA				
State	$ 75,000,000	Nov., 1920		
Aitkin county	250,000			
Anoka county			$ 250,000	
Beltrami county	350,000			
Benton county	250,000			
Big Stone	50,000			
Brown county	150,000			
Cass county	410,500			
Chisago county	250,000			
Cook county	50,000			
Crow Wing county			125,000	
Dakota county			250,000	
Douglas county	60,000			
Fillmore county	40,000			
Goodhue county			125,000	
Houston county	250,000			
Hubbard county	20,000			
Itasca county			2,000,000	
Kanabec county	75,000			
Kandiyohi			250,000	
Lake county	50,000			
Leseur county			250,000	
Lincoln county	250,000	Oct. 14, 1919		
Mahnomen county	100,000			
Morrison county	200,000			
Mower county	65,000			
Murray county	100,000			
Nobles county			125,000	
Olmsted county			250,000	
Pine county	100,000			
Pipestone county			250,000	
Polk county			125,000	
Rice county			250,000	
Rock county			300,000	Oct. 7, 1919
St. Louis county			7,500,000	
Sherburne county			250,000	
Stevens county			250,000	
Swift county			250,000	
Wabasha county	77,000			
Waseca county	105,000			
Washington county	250,000			
Watonwan county	250,000			
Totals	$103,752,500		$ 12,800,000	

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	Proposed	Date of Election	Authorized	Date of Authorized
MISSISSIPPI				
State	$ 25,000,000			
Adams county			$ 400,000	
Amite county			100,000	
Benton county			250,000	
Bolivar county			1,055,000	
Calhoun county			300,000	
Carroll county			250,000	
Chickasaw county			168,000	
Claiborne county			160,000	
Clarke county			50,000	
Coahoma county			500,000	
Copiah county			125,000	
Forrest county			50,000	
Franklin county			400,000	
Harrison county			150,000	
Holmes county			100,000	
Humphrey county			500,000	
Issaquena county			100,000	
Itawamba county			100,000	
Jackson county			100,000	
Jefferson county			300,000	
Kemper county			100,000	
Lamar county			150,000	
Lauderdale county			195,000	
Leake county			150,000	
Lee county			150,000	
LeFlore county			400,000	
Lowndes county			75,000	
Madison county			250,000	
Marion county			150,000	
Monroe county			100,000	
Noxubee county			130,000	
Oktibbeha county			100,000	
Panola county			150,000	
Pearl River county			400,000	
Pike county			500,000	
Pontotoc county			180,000	
Prentiss county			50,000	
Quitman county			750,000	
Rankin county			50,000	
Sharkey county			350,000	
Simpson county			175,000	
Stone county			60,000	
Sunflower county			500,000	
Tallahatchie county			500,000	
Tate county			700,000	
Tunica county			300,000	
Union county			100,000	
Walthall county			200,000	
Warren county			500,000	
Washington county			2,500,000	
Webster county			300,000	
Wilkinson county			150,000	
Yalobusha county			250,000	
Totals	$ 25,000,000		$ 15,773,000	
MISSOURI				
State	$ 60,000,000	Nov., 1920		
Andrew county	1,250,000			
Atchison county	1,000,000			
Audrain county	1,000,000	Sept. 16, 1919		
Barton county	750,000	Feb. 10, 1920		
Buchanan county			$ 2,000,000	
Butler county			500,000	
Caldwell county	1,000,000			
Cape Girardeau	1,000,000	Dec. 18, 1919		
Carroll county	1,100,000			

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	Proposed	Date of Election	Authorized	Date Authorized
MISSOURI—Continued				
Cedar county, 3 Districts			$ 76,000	
Christian county			120,000	
Clay county			1,250,000	
Albany township			100,000	
Clinton county	$ 1,250,000			
Cole county			300,000	
Cooper county	100,000			
Crawford county			250,000	
Dade county, 4 townships			77,000	
Daviess county	1,000,000			
Jamesport township	100,000			
DeKalb county	900,000			
Dunklin	1,000,000			
Gentry county				
Athens township			100,000	
Howard township			53,000	
Jefferson township			85,000	
Greene county	2,000,000	Sept. 15, 1919		
Grundy			135,000	Nov. 25, 1919
Henry county, 3 townships			140,000	Sept. 9 ,1919
Holt county	1,000,000			
Howell county			500,000	
Jasper county			700,000	Sept. 15, 1919
Laclede county	100,000			
Lawrence county				
Mt. Vernon District			36,600	July 5, 1919
Chesapeake district			5,000	July 5, 1919
Verona district			25,000	July 5, 1919
Lincoln county			800,000	
Lewis county, Lagrange district			50,000	
Mercer county	500,000			
Morgan county	300,000			
Newton county	1,000,000			
Nodaway county	2,000,000			
Grant township			40,000	June 21, 1919
Independent township			50,000	
Osage county			500,000	Sept. 27, 1919
Pemiscot county	760,000			
Perry county	425,000			
Pettis county			500,000	June 3, 1919
Bethany township			100,000	June 3, 1919
Phelps county			400,000	
Polk county	716,657	Dec. 16, 1919		
Johnson township			25,000	June 3, 1919
Putnam county	700,000			
Ray county	1,300,000			
St. Charles county	1,000,000			
St. Clair county			21,000	Nov. 25, 1919
St. Francis county	850,000			
St. Louis county			3,000,000	
Saline county				
Malta Bend district			68,000	
Scotland county	400,000	Sept. 13, 1919		
Scott county			1,000,000	
Shannon county	400,000			
Shelby county	1,000,000			
Stoddard county				
Bloomfield district			58,000	
Dexter township			185,000	July 18, 1919
Texas county			225,000	
Wayne county			30,000	
Totals	$ 85,901,657		$ 13,504,600	

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	Proposed	Date of Election	Authorized	Date of Authorized
MONTANA				
State	$ 15,000,000	Nov., 1920		
Big Horn county			$ 75,000	Sept. 2, 1919
Blaine county			100,000	Sept. 2, 1919
Broadwater county			100,000	Sept. 2, 1919
Carbon county			130,000	Sept. 2, 1919
Cascade county			500,000	Sept. 2, 1919
Dawson county			200,000	Sept. 2, 1919
Deer Lodge county			150,000	Sept. 2, 1919
Fallon county			275,000	Sept. 2, 1919
Fergus county			700,000	Sept. 2, 1919
Flathead county			70,000	Sept. 2, 1919
Gallatin county			400,000	Nov. 5, 1918
Granite county			150,000	Sept. 2, 1919
Hill county			150,000	Sept. 2, 1919
Jefferson county			100,000	Sept. 2, 1919
Lewis and Clark county			200,000	Sept. 2, 1919
Lincoln county			70,000	
Madison county			150,000	Sept. 2, 1919
Meagher county			150,000	July 8, 1919
Missoula county			250,000	Sept. 2, 1919
Musselshell county	300,000	Jan. 13, 1920		
Park county			150,000	July 8, 1919
Pondera county			150,000	Sept. 2, 1919
Powell county			100,000	Sept. 2, 1919
Ravalli county			100,000	Sept. 2, 1919
Roosevelt county			200,000	Sept. 2, 1919
Rosebud county			100,000	Sept. 2, 1919
Sanders county			75,000	Sept. 2, 1919
Silverbow county			250,000	Sept. 2, 1919
Stillwater county			163,000	Sept. 2, 1919
Sweet Grass county			125,000	Sept. 2, 1919
Teton county			150,000	Sept. 2, 1919
Toole county			200,000	Sept. 2, 1919
Wheatland county			200,000	Sept. 2, 1919
Wibaux county			75,000	Sept. 2, 1919
Yellowstone county			325,000	Sept. 2, 1919
Totals	$ 15,300,000		$ 6,283,000	
NEBRASKA				
Douglas county			3,000,000	June 24, 1919
NEVADA				
State			$ 1,000,000	
Elko county	$ 600,000			
Washoe county			200,000	
Totals	$ 600,000		$ 1,200,000	
NEW JERSEY				
Essex county	$ 605,000			
Monmouth county	3,450,000			
Total	$ 4,055,000			
NEW MEXICO				
State	$ 2,000,000	Nov., 1920		
Chaves county			$ 200,000	Sept. 23, 1919
Totals	$ 2,000,000		$ 200,000	
NORTH CAROLINA				
State	$ 25,000,000	Nov., 1920		
Alexander			$ 200,000	
Alleghany county			125,000	
Ashe county			600,000	
Beaufort county			1,000,000	April 29, 1919
Bertie county	100,000			
Bladen county	40,000			

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	Proposed	Date of Election	Authorized	Date of Authorized
NORTH CAROLINA—Continued				
Brunswick county			$ 35,000	
Buncombe county			300,000	
Burke county			80,000	
Caldwell county			250,000	
Lovelady township			25,000	
Camden county				
South Mills township			50,000	
Carteret county			500,000	
Caswell county			200,000	
Catawba county	$ 500,000			
Chatham county			300,000	
Chowan county	300,000			
Cleveland county				
Township No. 5			40,000	
Township No. 10			25,000	
Township No. 11			30,000	
Columbus county			50,000	
Craven county			150,000	
Currituck county			20,000	
Davie county			100,000	
Duplin county			200,000	
Durham county	750,000		250,000	
Edgecombe county	60,000			
Forsyth county	2,000,000		100,000	
Franklin county				
Gold Mine township			40,000	
Dunns township			50,000	
Harris township			50,000	
Gaston county	500,000			
Granville county			80,000	
Halifax county			500,000	
Harnett county				
Averasboro township			50,000	
Dukes township			30,000	
Henderson county	10,000			
Johnson county in townships	160,000		100,000	
Lenoir county			2,000,000	
McDowell county				
Dysartville township			6,000	
Higgins township			3,000	
Monford township			4,000	
Madison county				
District No. 12			6,000	
District No. 8			20,000	
Martin county			150,000	
Mecklenburg county	1,000,000			
Mithcell county				
Bakersville township			30,000	
Grassy Creek			50,000	
Montgomery county				
Troy township			30,000	
Biscoe township			30,000	
Nash county	600,000			
Dry Wells township			20,000	
Griffins township			20,000	
Onslow county	250,000			
Jacksonville township			10,000	
Richlands township			10,000	
Pamlico county			100,000	
Pasquotank county			500,000	
Pender county			100,000	
Topsail township			30,000	
Columbia township			10,000	
Caswell township			20,000	
Perquimans county			300,000	
Person county			225,000	
Pitt county			500,000	
Randolph county			150,000	

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	Proposed	Date of Election	Authorized	Date Authorized
NORTH CAROLINA—Continued				
Robeson county	$ 555,000		$ 255,000	
Rockingham county			725,000	
Rowan county	200,000			
Rutherford county				
Cool Springs township			875	
Chimney Rock township			1,240	
Green Hill township			1,835	
Rutherford township			6,685	
Sampson county			200,000	
Stokes county			260,000	
Surry county			500,000	
Tyrrell county	100,000			
Vance county			500,000	
Watauga county			200,000	
Wilkes county			525,000	
Yadkin county			50,000	
Yancey county				
South Toe township			30,000	
Northeastern Carolina Road District			500,000	
Totals	$ 32,125,000		$ 13,609,635	
OKLAHOMA				
Bryan county	$ 500,000			
Carter county	800,000			
Creek county			$ 1,000,000	Sept. 9, 1919
Garfield county	1,500,000			
Garvin county	500,000			
Kay county	1,500,000			
Muskogee county	1,000,000			
Oklahoma county	1,500,000			
Ottawa county	750,000			
Pontotoc county	500,000			
Pottawattomie county	555,000			
Pushmataha county				
Antlers township			129,000	
Kiamichi township			29,000	
Washington county, 2 districts	60,000			
Totals	$ 9,165,000		$ 1,158,000	
OREGON				
State			$ 10,000,000	
State—Roosevelt highway			2,500,000	June 3, 1919
Baker county			500,000	June 3, 1919
Benton county			220,000	June 3, 1919
Clackamas county	$ 1,700,000			
Curry county			90,000	
Deschutes county			125,000	June 3, 1919
Gilliam county			250,000	June 3, 1919
Grant county			90,000	June 3, 1919
Harney county			160,000	June 3, 1919
Jefferson county			100,000	June 3, 1919
Klamath county			347,704	June 3, 1919
Lake county			200,000	June 3, 1919
Lincoln county			180,000	June 3, 1919
Linn county			600,000	June 3, 1919
Malheur county			200,000	June 3, 1919
Marion county			850,000	June 3, 1919
Morrow county			290,000	June 3, 1919
Polk county			320,000	June 3, 1919
Sherman county			300,000	June 3, 1919
Tillamook county			420,000	June 3, 1919
Umatilla county			1,050,000	
Wallowa county			500,000	June 3, 1919

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	Proposed	Date of Election	Authorized	Date of Authorized
OREGON—Continued				
Wheeler county			$ 44,000	June 3, 1919
Yamhill county			360,000	June 3, 1919
Totals	$ 1,700,000		$ 19,696,704	
PENNSYLVANIA				
State			$ 50,000,000	Nov., 1918
Allegheny county			3,151,506	
Armstrong county			1,000,000	May 20, 1919
Beaver county			750,000	July 1, 1919
Bedford county			350,000	
Berks county	$ 1,000,000			
Bradford county			1,000,000	
Cambria county	500,000			
12 Townships			943,400	
Chester county	2,500,000			
Clarion county			500,000	
Clearfield county	1,500,000			
Crawford county	1,000,000		200,000	
Erie county			1,416,647	
Greene county			1,000,000	
Indiana county				
5 Townships			226,000	
Jefferson county			500,000	June 10, 1919
Townships			400,000	
Lawrence county			1,750,000	
Lycoming county			500,000	
McKean county			750,000	
Mercer county			1,500,000	June 17, 1919
Schuylkill county			350,000	
Somerset county	1,000,000	Feb., 1920		
Tioga county	500,000			
Venango county			1,050,000	Nov. 4, 1919
Warren county			750,000	April 5, 1919
Washington county			1,000,000	June 17, 1919
Westmoreland county			750,000	
York county			2,500,000	Aug. 19, 1919
Totals	$ 8,000,000		$ 71,337,553	
RHODE ISLAND				
State	$ 1,000,000			
SOUTH CAROLINA				
Anderson county			$ 1,450,000	May 15, 1919
Beaufort county			320,000	
Charleston county	$ 500,000		275,000	
Cherokee county			300,000	
Chester county	1,000,000		450,000	Aug. 15, 1919
Clarendon county	1,000,000			
Fairfield county			300,000	
Florence county	1,500,000		40,000	
Greenwood county			600,000	
Laurens county	1,500,000		300,000	
Orangeburg county	1,000,000		50,000	
Pickens county			300,000	
Richland county			2,000,000	Aug. 4, 1919
Spartanburg county			1,000,000	
Sumter county	1,000,000			
Union county			1,175,000	
York county	60,000			
Totals	$ 7,560,000		$ 8,510,000	
SOUTH DAKOTA				
Beadle county	$ 2,500,000			
Clay county	2,000,000			
Day county	3,000,000			
Lake county	2,500,000			

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	Proposed	Date of Election	Authorized	Date of Authorized
SOUTH DAKOTA—Continued				
Union county	$ 1,500,000			
Yankton county	3,250,000	Dec. 9, 1919		
Total	$ 14,750,000			
TENNESSEE				
Benton county			$ 200,000	
Blount county			400,000	
Campbell county			200,000	
Canon county			90,000	
Carrol county			85,000	
Carter county			90,000	
Cheatham county			40,000	
Cocke county			135,000	
Coffee county			100,000	
Darren county			100,000	
DeKalb county			200,000	
Dyer county			150,000	
Fayette county			500,000	
Franklin county			750,000	
Gibson county			500,000	
Giles county			650,000	
Grundy county			200,000	
Houston county			100,000	
Jefferson county			150,000	
Knox county			200,000	
Lake county			100,000	
Madison county	$ 5,000,000			
Marion county			150,000	
Maury county			200,000	
Putnam county			100,000	
Rutherford county			200,000	
Sevier county			150,000	
Smith county			400,000	
Tipton county			600,000	
Union county			20,000	
Warren county			300,000	
Weakly county			125,000	
Totals	$ 5,000,000		$ 7,185,000	
TEXAS				
Anderson county			$ 75,000	
Bastrop county			320,000	
Bee county			600,000	April 19, 1919
Bexar county			1,500,000	May 24, 1919
Blanco county			75,000	
Bowie county			280,000	
Brazoria county			200,000	
Briscoe county			100,000	
Burnet county			70,000	
Callahan county			100,000	
Cameron county			300,000	
Yarrelton district			50,000	
Camp county	450,000			
Canton county	1,500,000			
Cass county			25,000	
Chambers county			150,000	
Cherokee county			650,000	
Coke county			60,000	
Coleman county			100,000	
Collin county			2,735,000	
Colorado county	110,000			
Comal county			175,000	
Comanche county district No. 2			750,000	
Cooke county			175,000	
Valley View district	225,000			
Coryell county	1,000,000			

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	Proposed	Date of Election	Authorized	Date Authorized
TEXAS—Continued				
Cottle county			$ 200,000	
Dallas county			6,500,000	May 24, 1919
Delta county			1,000,000	April 5, 1919
Denton county			1,500,000	Mar. 15, 1919
Krum district			125,000	
DeWitt county	$ 1,635,000		40,000	
Dimmit county	100,000			
Eastland county			4,500,000	Sept. 27, 1919
Edwards county			400,000	
Ellis county			1,212,000	
El Paso county			800,000	Nov. 15, 1919
Falls county			150,000	
Justice Prec. No. 1			500,000	
Fannin county	1,000,000		181,000	Mar. 28, 1919
Fayette county			325,000	
Fisher county			52,000	
Floyd county	500,000			
Fort Bend county	200,000			
Franklin county			1,000,000	Mch. 22, 1919
Freestone county			30,000	
Galveston county	400,000			
Gillespie county			200,000	
Gonzales county			4,333,000	
Grayson county	5,000,000		514,000	
Guadeloupe county			100,000	
Hale county	500,000			
Hardin county			510,000	
Harrison county			1,750,000	Mch. 19, 1919
Hartley county			75,000	
Hays county			415,000	May 10, 1919
Hemphill county	200,000			
Henderson county			1,150,000	
Hill county districts			2,401,000	
Hood county			140,000	
Houston county			250,000	
Hudspeth county			40,000	
Hunt county			2,000,000	Mch. 22, 1919
Jefferson county	2,000,000			
Jim Hogg county			25,000	
Johnson county			2,000,000	May 10, 1919
Karnes county			300,000	May 1, 1919
Kaufman county			1,850,000	Mch. 22, 1919
Kendall county			50,000	April 12, 1919
Kerr county			200,000	
Kimble county			150,000	
Kleburg county			350,000	
Knox county			100,000	
Lamar county			1,500,000	
Lamb county district trict No. 1			50,000	Mch. 27, 1919
Lavaca county			200,000	
Lee county			50,000	
Liberty county			1,000,000	
Limestone county			965,000	
Live Oaks county			130,000	
Lubbock county	500,000			
Matagorda county			175,000	
Medina county			30,000	
Menard county	275,000			
Milam county			465,000	
Montague county			125,000	
Montgomery county			108,000	
Moore county			30,000	
Morris county			50,000	
Nacogdoches county	800,000		800,000	May 26, 1919
Navarro county			66,000	
Nueces county			2,000,000	July 26, 1919
Orange county			1,000,000	May 1, 1919
Palo Pinto county			1,500,000	

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	Proposed	Date of Election	Authorized	Date of Authorized
TEXAS—Continued				
Panola county			$ 135,000	
Parker county			800,000	April 26, 1919
Pecos county			35,000	
Polk county			800,000	April 12, 1919
Potter county			750,000	
Rains county			250,000	April 24, 1919
Red River county districts			596,000	
Reeves county			85,000	
Rockwall county			800,000	
Rusk county			800,000	May 18, 1919
San Augustine county			510,000	May 17, 1919
San Jacinto			200,000	
San Patricio county			375,000	
Schleicher county			125,000	
Scurry county			200,000	
Shelby county			1,105,000	
Smith county			1,500,000	May 24, 1919
Somervell county			60,000	
Stevens county			3,500,000	Nov. 15, 1919
Sutton county			300,000	May 24, 1919
Tarrant county			3,450,000	July 26, 1919
Taylor county			25,000	
Titus county			1,000,000	Mch. 15, 1919
Tom Green county			500,000	Mch. 29, 1919
Trinity county precinct No. 2			100,000	
Tyler county			800,000	
Upshur county			1,060,000	
Uvalde county			450,000	
Van Zandt county			1,500,000	
Walker county			40,000	
Waller county			25,000	
Washington county			1,500,000	June 21, 1919
Webb county			300,000	June 14, 1919
Wharton county			2,000,000	
Wheeler county			120,000	
Wichita county			1,500,000	
Wilbarger county	$ 750,000			
Williamson county			1,500,000	June 14, 1919
Wise county	30,000			
Wood county			1,250,000	
Totals	$ 17,175,000		$ 86,023,000	
UTAH				
State			$ 4,000,000	
Millard county			360,000	
Salt Lake county			1,500,000	
Utah county			850,000	
Washington county			56,000	
Total			$ 6,766,000	
WASHINGTON				
State	$ 30,000,000	Nov., 1920		
Benton county	500,000			
Chelan county			830,000	Sept. 20, 1919
Douglas county			380,000	
Grays Harbor county			400,000	April 15, 1919
Kitsap county	300,000			
Mason county			250,000	June 14, 1919
Pierce county			2,500,000	May 31, 1919
Spokane county			3,225,000	July 1, 1919
Walla Walla county	80,000	Dec. 16, 1919	70,000	June 24, 1919
Yakima county			600,000	April 26, 1919 July 26, 1919
Totals	$ 30,880,000		$ 8,255,000	

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	Proposed	Date of Election	Authorized	Date of Authorized
WEST VIRGINIA				
State	$ 50,000,000	Nov., 1920		
Boone county	288,000		$ 200,000	
Doddridge county				
McClellan district			250,000	
Fayette county				
Mountain Cove district			125,000	June 10, 1919
Quinniment district			194,000	June 18, 1919
Kanawha district			379,000	May 20, 1919
Grant county				
Union district	200,000			
Greenbrier county				
Anthony Creek district	27,800	Nov. 15, 1919		
Meadow Bluff district			126,000	April 12, 1919
Blue Sulphur district	100,000			
Frankford district	43,000			
Hancock county				
Butler district			100,000	May 24, 1919
Harrison county	4,000,000			
Kanawha county				
Malden district			80,000	Aug. 12, 1919
Elk district			395,000	Aug. 12, 1919
Union district			160,000	Aug. 12, 1919
Cabin Creek district			904,000	Aug. 12, 1919
Jefferson district	230,000			
Poca district	25,000			
Washington district	60,000			
Lewis county				
Freeman's Creek district	300,000			
Hacker's Creek district	300,000			
Logan county			1,000,000	Nov. 29, 1919
Marion county				
Mannington district	500,000			
Union district	300,000			
Winfield district	115,000			
Marshall county			385,000	Nov. 4, 1919
Mason county				
Arbuckle district	40,000			
Robinson district	65,000			
Cooper district	57,000			
Union district	40,000			
Waggoner district			70,000	May 24, 1919
Graham district			58,000	
Mineral county				
Elk district			137,000	April 19, 1919
Monongalia county				
Cass district			300,000	April 2, 1919
Grant district			325,000	July 2, 1919
Union district			150,000	Sept. 6, 1919
Clay district	200,000			
Batelle district	310,000			
Morgan county	250,000			
Ohio county	1,000,000			
Putnam county				
Scott district	100,000	Sept. 16, 1919		
Union district	100,000	Sept. 16, 1919		
Teays Valley district	51,000			
Raliegh county				
Clear Fork district			147,000	Oct. 31, 1919
Marsh Fork district			195,000	Sept. 5, 1919
Randolph county	1,000,000			
Beverly district			94,000	
Ritchie county	1,000,000			
Roane county				
Reedy district			67,000	June 24, 1919
Summers county				
Jumping Branch district			30,500	May 3, 1919

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	Proposed	Date of Election	Authorized	Date Authorized
WEST VIRGINIA—Continued				
Pipestem district			$ 22,700	June 14, 1919
Green Sulphur district	$ 110,000			
Forest Hill district	27,500			
Taylor county	1,000,000			
Tyler county				
Union district	150,000			
Wayne county			1,000,000	March, 1918
Webster county	225,000			
Wetzel county	1,500,000			
Clay district			105,000	July 12, 1919
Wirt county	250,000			
Wood county				
Clay district			40,000	June 17, 1919
Wyoming county				
Slab Fork and Barker's Ridge district	140,000			
Total	$ 64,104,300		$ 7,039,200	
WISCONSIN				
State	$ 50,000,000			
Brown county			2,790,000	Aug. 29, 1919 Nov., 1919
Calumet county	2,700,000	Dec. 16, 1919		
Dane county	10,000,000	Dec. 16, 1919		
Dodge county			5,400,000	Dec. 23, 1919
Douglas county			1,500,000	Nov. 4, 1919
Florence county			100,000	
Fond du Lac county			4,500,000	Dec. 16, 1919
Grant county	5,000,000	Dec. 16, 1919		
Green county			3,000,000	Sept. 23, 1919
Green Lake county			900,000	Dec. 18, 1919
Iowa county	2,750,000	Dec. 16, 1919		
Jefferson county			2,000,000	Sept. 2, 1919
Manitowoc county	3,750,000	Jan., 1920		
Marathon county	4,250,000	Dec. 17, 1919		
Oconto county	1,325,000	Dec. 23, 1919		
Outagamie county	1,800,000	Dec. 17, 1919	180,000	April 12, 1919
Ozaukee county			1,500,000	
Portage county	1,500,000			
Racine county			2,650,000	Dec. 13, 1919
Rock county			1,500,000	Mar. 29, 1919
Sheboygan county	4,200,000	Dec. 16, 1919		
Taylor county	860,000	Dec. 20, 1919		
Walworth county			3,000,000	Dec. 16, 1919
Washington county			2,000,000	Sept. 2, 1919
Waukesha county			3,800,000	Dec. 16, 1919
Waupaca county	180,000			
Winnebago county	3,000,000		205,000	
Wood county			1,500,000	Sept. 2, 1919
Totals	$ 91,315,000		$ 36,525,000	
WYOMING				
State			$ 2,800,000	April 26, 1919
Grand total	$694,642,457		$606,971,537	

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CONVICT LABOR FOR ROAD WORK

By H. S. FAIRBANK, *Senior Highway Engineer, Bureau of Public Roads.*

After the close of the Revolutionary War an act was passed by the Legislature of Pennsylvania providing that certain crimes, which until then had been capitally punished, should thereafter carry the penalty of labor "publicly and disgracefully imposed." Under this law convicts were employed in cleaning streets and repairing roads in and about Philadelphia and, to satisfy the public demand for the disgrace and degradation of the criminal, the men thus publicly exposed were marked by shaven heads and hideous uniforms. As might have been expected, the experiment was a complete failure. An official report a few years later stated that "The severity of the law and the disgraceful manner of executing it led to a proportionate degree of depravity and insensibility and every spark of morality appeared to be destroyed." The law was repealed, the first penitentiary in the United States was established in Philadelphia, and thereafter all convict labor in the State of Pennsylvania was performed within its walls.

The other States followed the lead of Pennsylvania and nearly all built penitentiaries. Labor remained as the principal element of penal regime, but it was regarded as a settled fact that convict labor should always be enforced within prison walls.

Early practice, following the principle that whatever labor was prescribed must be punitive in character, favored the imposition of endlessly monotonous tasks such as oakum picking and crank turning. No tangible result was sought from the labor; the simple purpose was to provide labor, weary, unceasing, hopeless labor, to break the spirit and curb the criminal impulses of the offender.

The substitution of useful tasks came largely as a result of the desire of our thrifty forefathers to make the criminal pay for his own punishment. They found that by the simple expedient of leasing the convicts to manufacturers of harness, hollow-ware or house brooms, they could not only relieve themselves of the cost of clothing and feeding their delinquent brothers, but actually derive a fair profit from their labors. A trial convinced them that the duty of making the punishment fit the crime would not be neglected by the lessees. Happily the system has now been abandoned under pressure of enlightened sentiment in all of our States.

A number of the States, for financial reasons, still permit the

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employment of convicts by private manufacturers under the contract and piece-price systems, but all signs point to the fact that it will not be long until these systems, also, will be abandoned and the wealth produced by convict labor will accrue to the State alone.

The opposition of manufacturers and organized labor to the competitive sale of prison-made products in the markets of the Nation is gradually limiting prison labor to production for State use only, and, in the States which depend upon prison shops for the necessary employment of convicts, is creating a new problem for prison officials. While State institutions require a great variety of articles which might be made in the penitentiary, the demand for each article is limited. Obviously the State cannot equip its penal institutions to manufacture all of the articles used by State institutions, but, if it devotes its efforts to the production of a few articles, the demand is likely to be insufficient to furnish full-time employment for all convicts.

To prison officials faced with this dilemma the suggestion that a part of the States' prison population be employed in building public roads should point a way out of the difficulty.

The public demand for more and better roads is stronger now than at any time in our history. But it is one thing to recognize that a demand exists. It is something much more difficult to satisfy it. Since the war the cost of road construction has advanced by leaps and bounds, until at this time the cost of a reasonably good highway has reached proportions which have led some States to consider the abandonment of projected road programs until prices return to something like their pre-war level. The inflation of highway expense is of course due partly to increase in the cost of materials, but it is also due in part to unprecedented increases in the wages of labor.

In this situation the employment of convict labor will add measurably to the realization of the general demand for roads. Our convicts must be maintained whatever be the work at which they are employed. While their maintenance is somewhat more expensive in road construction camps than in the penitentiaries, the added expense is not great, and the whole cost would be far less than the present wages of free labor. No field can be selected in which the expenditure of prison labor can be applied with greater benefit to the States, for the reason that, as a whole, there is no greater public need than the improvement of the highways. There is every reason to believe that, properly conducted, road work may be carried on with as much efficiency as the penitentiary industries, and it has the advantage that no sale or transfer of the product is required to place it in public use. Competition

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with free labor is, therefore, reduced to a minimum, and indeed, it may almost be said, that no free laborer is deprived of work, since much of the work which can be performed by convicts could not be undertaken at all, for financial reasons, if it were necessary to employ free labor.

Although the convicts' labor so applied may be of very great benefit to the State, it is also of benefit to the convict himself. For the average prison inmate the advantage of open air work is most pronounced, for an examination of prison statistics shows that of all inmates about two-thirds, prior to conviction, were engaged in outdoor occupations, about one-tenth belong to the professional and mercantile classes and only about one-fourth are fitted by previous habits of life to endure the confinement of penitentiary shops.

The success or failure of road work as an employment may generally be predicted by the attitude of the public and officials toward it. If, on the one hand, it be regarded as a form of punishment, or if the ruling principle be simply to exact valuable labor at low cost, the project is as sure to fail now as it did in the early days in Pennsylvania. On the other hand, when assignment to the road camp is reserved as a reward for those prisoners who have proved their merit and good intention by their record in confinement, the chances of success are overwhelming. By doing away with the customary marks of prison degradation, by permitting the exercise of initiative, within limits, by granting a greater degree of freedom as the ability and desire to use it properly are manifested, the very publicity of the convicts' position on the roads is transformed from a mark of disgrace to an acknowledgment of the confidence of his keepers; and by practice in self-restraint under guidance in the camp, the prisoner is fitted to live a life of similar circumspection after discharge. Indeed it is possible by providing in this way for road work in conjunction with other industries, inside the walls, to promote the discipline of the entire penal institution.

The "Honor System," either in pronounced or modified form, is the plan which has been adopted by all the States which have lately resorted to road work for convict employment. Success or failure largely depends on the care and judgment used in the selection of the men who are to work under it. Full consideration should be given to the history of the individual prisoner prior to conviction, the character of his offense, the circumstances surrounding its commission, and his traits of character as observed during a probationary term of close confinement. No prisoner should be trusted for road work who has not previously served such a probationary term within the prison. The selection is

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governed by no hard and fast rules; it is a matter of judgment. A few prison officials believe it is safe to trust only prisoners with relatively short terms, yet the experience of many wardens goes to show that the long-term man is not much more likely to attempt to escape than the short-term prisoner. In general, preference is given to prisoners convicted of impulsive crimes. Many prisoners serving sentences for murder, manslaughter, assault, and grand larceny are found to be absolutely trustworthy when placed on honor; but there is considerable hesitancy in trusting to the honor of the sneak thief, the pickpocket, the burglar or any prisoner convicted of a petty crime against property. In the South there is a popular belief that the Honor System cannot be applied successfully to negroes; yet long experience in Colorado and other Western States shows that they are not noticeably less amenable than the whites. An experiment conducted by the United States Office of Public Roads and Rural Engineering in Fulton County, Georgia, in 1916, furnished the most convincing proof of the inaccuracy of the popular assumption by a demonstration in the heart of the South.

Aside from proper selection of the road camp population, the measure of success achieved depends greatly on the character of the officials who are placed in charge of the men in the camp. Unless they possess the ability to win the respect of the prisoners and cultivate sentiments of loyalty and pride, no great measure of success can be looked for. Finally, it is impossible to emphasize too strongly the desirability, from all standpoints, of careful supervision of the comfort and health of the inmates, the sanitary condition of the camp and the character of the food served.

Viewed from a purely mercenary standpoint, care and attention given to these details is amply repaid by the superior working efficiency of the force which invariably follows. A graphic illustration of this fact is furnished by the experience of Rhode Island, one of the latest States to employ convicts on road work. Two camps were established in that State, in 1917. At the first camp, which was known as Camp No. 1, the men were housed in a large and leaky tent, which at times was also uncomfortably cold. Lack of proper attention by inefficient camp officials resulted in the serving of unsuitable food. At Camp No. 2 the men were housed in a portable wooden building, which was a satisfactory shelter in every way, the guards were of a higher type, and no trouble was experienced in serving good food at all times. In the words of the chief engineer of the Board of Public Roads, "The results secured by the employment of the convicts at Camp No. 1 were never wholly satisfactory, while the results secured by the use of the convicts at Camp No. 2 were highly

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satisfactory, both as regards costs and quality of work done. Attempted escapes at Camp No. 1 were rathter frequent, but attempts to escape from Camp No. 2 were practically unknown."

As both of the roads constructed by convict labor had previously been advertised for contract bids, it was possible to draw an interesting comparison between the cost of work by contract and convict labor. The State highway department paid the penal and charitable commission for the labor of the convicts at the rate of $1.50 per day at first, but later the rate was increased to $2.25 per man per day, straight time, no deduction being made for days when weather permitted no work to be done. At these rates, the actual cost of work done by convicts at Camp No. 1 was $26,054.68. The cost at the lowest contract bid would have been $23,686.72. At Camp No. 2 the convict work cost $21,105.24, compared with the contractor's price of $25,462.81. In both cases the use of the convicts probably resulted in a saving to the State, because, although the charge paid for the labor by the highway department was from $9 to $15.75 per week, the actual cost of maintaining the convicts at the two camps was only $6.65 per week. But the efficiency of the work at Camp No. 2 was evidently higher than that of Camp No. 1.

As this example indicates, it is practically impossible to assert as a general proposition that convict labor is either more or less efficient and economical than free labor. Too much depends on the conditions surrounding the work.

Considered as an individual worker, the average convict is probably slightly less efficient than the average free laborer. As a class, convicts undoubtedly possess a lower order of intelligence, and less initiative, ability, and willingness in the performance of honest work than free men. But in comparing the economy of convict and free labor gangs it must be considered that, even though the convicts be actually less efficient than the free laborers, man for man, the work of the convict gang may still be more productive than the free-labor force at the same cost, because of the difference between the cost of maintaining the convict and the wage of free labor.

This great advantage which is inherent in the use of convict labor may be entirely lost by bad management in any number of ways. But a study of the experiences of those States which have employed convicts in road work for the longest periods shows that the inherent economy of convict labor may be preserved:

1. Close attention to the cost of maintenance of the convict, and unremitting honest effort to reduce it to a minimum consistent with proper living conditions and discipline.

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Number and Percentage of State Convicts Employed on Road Work in the Various States in 1919

STATE	Total Number of Convicts	Number of Convicts on Road Work	Percentage of Total Number on Road Work
Alabama	2,214	....	....
Arizona	256	125	49
Arkansas	756	137	18
California	3,012	327	11
Colorado	560	200	36
Connecticut	542	....	....
Delaware	482	32	7
Florida	1,200	250	21
Georgia	2,838	2,563	90
Idaho	235	....	....
Illinois	3,400	....	....
Indiana	1,926	....	....
Iowa	1,083	....	....
Kansas	No report	....	....
Kentucky	No report	....	....
Louisiana	1,370	....	....
Maine	254	10	4
Maryland	No report	....	....
Massachusetts	3,450	12	1
Michigan	No report	....	....
Minnesota	862	....	....
Mississippi	1,121	11	1
Missouri	2,591	87	3
Montana	No report	....	....
Nebraska	279	....	....
Nevada	No report	....	....
New Hampshire	No report	....	....
New Jersey	1,004	154	15
New Mexico	421	79	19
New York	4,336	150	3
North Carolina	734	168	23
North Dakota	118	....	....
Ohio	3,094	....	....
Oklahoma	1,271	204	16
Oregon	288	....	....
Pennsylvania	No report	....	....
Rhode Island	448	....	....
South Carolina	No report	....	....
South Dakota	152	....	....
Tennessee	No report	....	....
Texas	No report	....	....
Utah	131	60	46
Vermont	178	30	17
Virginia	1,546	897	58
Washington	No report	....	....
West Virginia	915	130	14
Wisconsin	818	23	3
Wyoming	339	18	5

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2. Elimination, as far as possible, of all losses of working time.
3. Granting positive rewards, in money or greater privileges, as an incentive to industry rather than the negative fear of punishment.
4. Elimination of politics as a factor in the selection of officials.
5. Offering sufficient salary inducements to officials to command the services of capable men.
6. Combining responsibility and authority for direction of road work and discipline of convicts in one person at each camp.
7. Suitable diversification of employment, providing for the large body of convicts the kind of work in the performance of which they manifest the greatest ability.
8. Seeing that the work provided is sufficient to keep all hands busy, and is large enough to provide employment for a camp of economical size. A small camp is never a cheap camp.
9. Providing a more mechanical kind of work for short-term prisoners or, if they must be employed at road work, by separating them from the long-term men.

Nation-wide experience, gained in many instances at the expense of costly failures, demonstrates that rigid adherence to these common-sense rules will insure the success of the plan to use convict labor for road work in any locality.

The following statistics, obtained by interrogation of State officials, indicate the extent to which road work has been adopted for convict employment by the various States.

State or county convicts are employed on the roads in 32 of the 48 States.

County convicts, only, are so employed in 4 States.

State convicts, only, are employed in about 13 States.

The percentage of State convicts employed on road work varies in the various States from less than 1 per cent to 90 per cent.

In the 37 States from which full information has been received, an average of 4.4 per cent of the State convicts are at work on the roads, and in the 22 States of this group which employ State convicts on road work at all, the average percentage of the total number so employed is 20 per cent.

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HIGHWAY ENGINEERING EDUCATION

Success of road building in this country depends largely upon the ability of the Government, the States, the counties, and the large contracting firms to obtain an adequate number of men qualified by educational training and practical experience properly to direct the construction and maintenance of our public roads.

In a recent interview, Dr. F. H. Newell, president of the American Association of Engineers, said:

"In general there is a good demand for engineers, but the greatest activity is in highway building. In this line there is a scarcity of experienced men. Much money is being wasted for this reason. The general enthusiasm for hard roads on the part of the public is apt to have a severe setback when the fact is discovered that many of the politically appointed boards of supervisors—not engineers—are wasting funds on experiments or schemes not approved by skilled engineers."

When the U. S. Bureau of Public Roads was established in 1893, there were few, if any, colleges in the country which gave instruction in road building. The position of highway engineer was then unknown. Harvard University was among the first, if not the first college, to establish a road-building course, and to provide a laboratory for the testing of road materials. A survey of the situation in 1909 indicated that less than 50 per cent of the engineering institutions of the country maintained courses in highway engineering.

In 1917, 76 colleges and universities had established courses of instruction along this line, mostly, however, as a part of the general course in civil engineering. Out of a total of 127 engineering schools in this country, there are at present 110 which have courses in highway engineering, thus indicating that the educators of the country are now beginning to grasp the significance of the road movement and to realize the need for trained highway engineers.

Dr. Philander P. Claxton, United States Commissioner of Education, has expressed himself as being much interested in this subject, and has therefore directed that a thorough study of the whole situation be made by a specialist of his bureau, in order to determine the character and extent of existing courses in highway engineering and the number of students taking these courses. His ultimate idea is to ascertain what, if anything, can be done to improve existing courses and to encourage colleges and univer-

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sities to turn out a greater number of trained highway engineers to meet the existing demand.

It appears from information obtained from the college catalogues that most of the instruction thus far given consists of lectures and class-room work, and that comparatively few of the higher educational institutions offer definite courses leading to a degree of highway engineering. Subjects relating to highway engineering are generally taught in connection with the usual civil engineering course, the highway engineering course generally being optional after one or two years in the civil engineering course.

Only a small percentage of the colleges appear to have laboratories in which students are required to devote a portion of their time to routine laboratory and research work in connection with the testing of materials used in road, street and bridge building and repair. Even a smaller percentage of colleges apparently require students to devote a portion of their time to field work. However important the class-room work may be, it is essential that students in highway engineering should have some laboratory experience and some field work, such as the making of plans, profiles, cross-sections, specifications and estimates of a sufficient mileage of the various classes of roads to familiarize them with the work and to enable them to put into practice the information which they have obtained through class-room instruction and lectures, before they can expect to achieve the highest degree of success. If an engineering graduate is well grounded in the rudiments of his profession, his period of apprenticeship in order to obtain the necessary experience and training is materially shortened.

In addition to the regular highway work, there is now developing a new field which calls for men who are equipped by training and experience to handle traffic problems. Economy and efficiency in highway transport is now becoming an important phase of the subject.

The indications are that twice as much will be spent in 1920 for highways construction as for railroad construction. There is therefore a greater need for highway engineers than for railroad engineers.

In all of the States in which highway departments have been established within the past few years, especially in the Southern States, more highway engineers for State work are urgently needed. There are over 3,000 counties and thousands of townships and districts in which road work is being carried on independently of State authorities. The great bulk of the road funds derived from taxation and bond issues is being expended by these

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political subdivisions of States and much of it is being carried on without engineering direction.

Unless more highway engineers can be produced and unless local authorities can be induced to place the work in the hands of such engineers, the results will be disastrous, and, as President Newell says, "public funds will be wasted on experiments and schemes not approved by skilled engineers."

Not only should local communities be induced to employ engineers, but they should also be encouraged to pay salaries commensurate with the duties and responsibilities, which unfortunately is not always the case at present.

In spite of the feeling that engineers are not needed in some communities, there are many other places where the authorities are beginning to see the importance of employing competent engineers. It can be said, therefore, without fear of contradiction, that there is probably no branch of engineering that at present offers a better or broader field of opportunity than that of highway engineering.

Courses in Highway Engineering Offered by Schools, Colleges and Departments of Engineering, 1918-1919[1]

Institutions, Names of Courses, and Time Allotted to Each Course

Alabama Polytechnic Institute, Auburn—Roads and pavements, 2d and 3d terms, 5 hours; roads, materials, laboratory, 4 hours, 2d term; road and street improvement, 4 hours, 3d term; practical work in railway, highway, and hydrographic surveying, 4 weeks, 48 hours per week.

University of Alabama, University—Highway engineering, 2 hours' credit, first half-year; roads and pavements, 2 hours' credit, second half-year.

University of Arizona, Tucson—Materials testing, one 3-hour laboratory period, one unit; highway engineering, 2d semester, two recitations, two units.

University of Arkansas, Fayetteville—Highways, 2 hours a week; highway engineering, 3 hours a week; highway bridges and culverts, 4 hours a week; highway engineering, laboratory, 4 hours a week.

University of California, Berkeley—Highway engineering, 2 hours first half-year; civil engineering, laboratory, 5 hours first half-year, 2 units; civil engineering, laboratory, 3 hours second half-year, 1 unit.

University of Southern California, Los Angeles—Highway engineering, 2 units, 2d semester.

Throop College of Technology, Pasadena, Calif.—Highway engineering, 2d term, junior year, 5 units.

University of Santa Clara, Santa Clara, Calif.—Materials, testing, laboratory, 1 credit, 2 hours, laboratory, 1st semester; roads and pavements, 2 credits, 2 hours, 1st semester.

University of Colorado, Boulder—Roads and pavements, autumn quarter, 3 hours lecture, 3 hours laboratory.

[1] Compiled by the United States Bureau of Education.

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Colorado State College of Agriculture and the Mechanic Arts, Fort Collins—Highway construction, 2 hrs.; attendance, 2 credits, 1st semester, senior year; road testing laboratory.

Colorado College, Colorado Springs—Roads, pavements and parks, 2d half senior year, 2 hours' credit; testing laboratory, 2d half-year, one 3-hour laboratory period a week, 2 hours' credit.

Yale University, Sheffield Scientific School, New Haven, Conn.—Highway engineering, 4th year civil engineering, 1st term, 3 recitations, 1 lecture and 3 hours of computation and design per week.

Delaware College, Newark, Del.—Highways, recitations and lectures, senior year; highway design, 5 hours, senior year.

George Washington University, Washington, D. C.—Highways and pavements, 2 hours a week, 4 semester hour credits.

The Catholic University of America, Washington, D. C.—Highways engineering, lectures and recitations, 1st half-year.

Howard University, Washington, D. C.—Roads and pavements, seniors, 2 lecture-recitations and 3 field periods per week, winter.

University of Florida, Gainesville—Highway engineering, recitations, 2 hours a week, 2d semester.

University of Georgia, Athens—Highway engineering, 3 hours per week, junior year.

Georgia School of Technology, Atlanta—Highway engineering, 1st term, 2 lectures, 3 hours laboratory; highway engineering, 2d term, 3 lectures, 6 hours laboratory.

College of Hawaii, Honolulu—Roads and pavements, 1st and 2d semesters, 2 credits each.

University of Idaho, Moscow—Roads and pavements, 3 credits, 1st semester.

Armour Institute of Technology, Chicago, Ill.—Highway engineering, 3 hours per week, 1st semester.

University of Illinois, Urbana—Roads and pavements, 3 semester hours; highway design, 3 semester hours; highway administration, 3 semester hours; road materials, 2 semester hours; public service engineering; highway construction: course for graduates, twice a week, 1 unit; road laboratory.

Purdue University, Lafayette, Ind.—Highway engineering, 2 semesters; roads and pavements, 2 hours.

University of Notre Dame, Notre Dame, Ind.—Roads and pavements, 2 hours a week for one term.

Valparaiso University, Valparaiso, Ind.—Municipal engineering, 12 weeks, 5 hours recitation, 5 hours drafting and field work.

Iowa State College of Agriculture and Mechanic Arts, Ames—Roads and pavements, fall or winter, 3 recitations per week, 3 credits; highway design, spring, 1 recitation, one 3-hour laboratory period per week, 2 credits; highway bridges, winter, two 3-hour periods per week, 2 credits; road materials testing, fall, 1 recitation, two 3-hour laboratory periods per week, 3 credits; highway administration, winter, 2 recitations per week, 2 credits; highway specification, spring, 3 recitations per week, 3 credits; highway engineering.

State University of Iowa, Iowa City—Highways, 3 periods a week, 1 hour credit.

University of Kansas, Lawrence—Roads and pavements, 2 hours credit; pavements (graduate course), 3 hours credit.

Kansas State Agricultural College, Manhattan—Highway engineering: (1) principles, senior year, 1st semester, 2 hours class work, 2 semester credits; highway engineering: (2) highway laws, administration, eco-

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nomics, senior year, 2d semester, 2 hours class work, 2 semester credits; highway engineering: (3) laboratory, field and drafting room, 6 hours, 2 semester credits.

University of Kentucky, Lexington—Highway location, construction and maintenance, 2 hours a week, 1st semester; streets and pavements, 5 hours a week, 1st half of 2d semester; road material, laboratory, 2 hours a week, 2d half of 2d semester; asphalt laboratory, 4 hours a week, 1st half of 2d semester; road-making for agricultural students, 3 hours a week, 2d half of 2d semester; highway bridge design, drawing, 8 hours a week, 1st half of 2d semester; highway engineering, advanced course for graduate civil engineers, 24 hours a week throughout the year.

University of Kentucky, Lexington—Highway location, construction and maintenance, 2 hours a week, 1st semester; streets and pavements, 5 hours a week, 1st half of 2d semester; road material, laboratory, 2 hours a week, 2d half of 2d semester; asphalt laboratory, 4 hours a week 1st half of 2d semester; road-making (for agricultural students), 3 hours a week, 2d half of 2d semester; highway bridge design, drawing, 8 hours a week, 1st half of 2d semester; highway engineering (advanced course for graduate civil engineers), 24 hours a week throughout the year.

Louisiana University and Agricultural and Mechanical College, Baton Rouge—Roads and pavements, 2 hours a week, lectures, and 4 hours a week, practice, 2d term; highway engineering, design of highway bridges and culverts, 2 hours a week, lectures.

University of Louisiana, New Orleans—Roads, streets and pavements, recitations and problems.

University of Maine, Orono—Highway construction, 2 hours a week; roads and trails, 1 hour a week; roads, materials, laboratory, 2 hours a week; highway design, 4 hours a week; highway engineering, advanced course, 2 hours a week.

Johns Hopkins University, Baltimore, Md.—Transportation, a study of railroads, canals, and highways as system of communication, etc., 3 hours weekly, 1st half-year.

Maryland State College of Agriculture, College Park, Md.—Highways, lectures and recitations, 2 hours, 1st term, 2 credits; highway engineering (advanced course) lectures and recitations, 2 hours, 2d and 3d terms, practice, 3 hours 2d term, 6 hours 2d term, credit 7 hours; materials, laboratory, practice, 3 hours 2d term, 1 credit; country roads, elementary course, lectures and recitation 2 hours, practice 3 hours, 3d term.

Massachusetts Institute of Technology, Cambridge—Highway engineering, 20 lectures, 3d year, 2 hours per week; testing highway materials, 2d term, 3d year, 6 hours per week for last 5 weeks, lectures and laboratory exercises.

Tufts College, Tufts College, Mass.—Highways, 1 recitation and 1 3-hour laboratory period per week.

Worcester Polytechnic Institute, Worcester, Mass.—Highway construction.

University of Michigan, Ann Arbor—Municipal engineering, 2 hours, 2d semester; highway engineering, 2 hours, both semesters; highway engineering economics and theory, 2 hours, 2 semesters; highway engineering, laboratory, 2 hours, both semesters; highway engineering, design, 3 hours, 2d semester; bituminous paving materials, 1 hour, 1st semester. Graduate Short-Period Courses—Highway transport, 1 hour credit; bituminous surfaces and bituminous pavements, 3 hours' credit; highway laboratory research, 2 to 3 hours' credit; highway bridges, 2 hours' credit; specifications and contracts, 2 hours' credit; earth, gravel and broken stone, 2 hours' credit.

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University of Detroit, Detroit, Mich.—Roads and pavements.

Michigan Agricultural College, East Lansing, Mich.—Agricultural engineering, 5 lecture hours a week, fall term; pavements, 2 lecture and recitation hours a week, winter term; road construction, 2 recitation hours and 6 hours of field work a week, spring term.

University of Minnesota, Minneapolis—Highways and pavements (elementary course); highways and pavements, with laboratory practice (continuation of first course); city planning; highway administration (graduate course).

Mississippi Agricultural and Mechanical College, Agricultural College, Miss.—Road construction, spring quarter, 1 hour; road construction, laboratory, spring quarter, 2 hours; highway engineering, spring quarter, 4 hours.

University of Mississippi, University—Highway construction; highway engineering; highway surveying.

University of Missouri, Columbia—Road materials; roads and pavements; highway engineering; country roads; highway design.

Washington University, St. Louis, Mo.—Roads, streets, and pavements, 2 lectures a week, 1st semester, senior year.

Montana State College Agricultural and the Mechanical Arts—Municipal engineering, autumn, 3 credits; highway engineering, preliminary investigations, etc., spring, 3 credits; highway engineering, roads and pavements, winter, 3 credits; roads, materials, laboratory.

University of Nebraska, Lincoln—Road materials testing, 3 hours, laboratory, 2 hours' credit, 1st and 2d semesters; road materials, testing, continued, 6 hours, laboratory, 2 hours' credit, 1st and 2d semesters; research work in rural architecture (farm drainage and rural highways), 2 to 5 hours' credit; irrigation, drainage, and rural highways, 2 hours' attendance, 2 hours' preparation, 5 hours' field work and drawing, 3 hours' credit, 2d semester; railway and highway surveying, 1 hour attendance, 6 hours field, 2 hours' preparation, 3 hours' credit, 1st semester; railway and highway construction, 2 hours' attendance, 4 hours' preparation, 2 hours' credit, 1st semester; roads, streets and pavements, 2 hours' attendance, 4 hours' preparation, 2 hours' credit, 1 semester.

University of Nevada, Reno—Rural engineering, (I) roads, drainage, sewage, irrigation, etc., 2 hours, 2 credits, 2d semester; rural engineering, (II) laboratory, 2 periods, 2 credits; highway engineering, 4 credits.

Dartmouth College, Thayer School of Civil Engineering—Highway construction and maintenance. Civil engineering course at Dartmouth is 2 years in length, preceded by 3 years of college preparation.

Rutgers College and the State University of New Jersey, New Brunswick.

Princeton University, Princeton, N. J.—Municipal engineering; railroad and road engineering, 2d term, 3 credits a week.

University of New Mexico, Albuquerque—Road engineering, 5 hours a week.

New Mexico College of Agriculture and Mechanic Arts, State College—Highway engineering, 3d term, 3 hours.

Polytechnic Institute of Brooklyn, New York—Highway engineering, 2 hours, 2d semester.

Cornell University, Ithaca, N. Y.—Highway engineering for seniors and graduates, 3 hours' credit; highway laboratory, juniors and seniors, 3 hours' credit; engineering construction, juniors, 2d term, 3 hours' credit; railroad and highway engineering.

The College of the City of New York, New York—Pavements, spring

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term, 3 hours a week; materials of construction, street pavement and highway materials.

Columbia University, New York City—Highway engineering; maps and road plans.

New York University, New York City—Highway engineering, 2 hours, 2 credits, 1st term.

Union University, Schenectady, N. Y.—Highway engineering, 3 hours a week, 2d semester.

Syracuse University, Syracuse, N. Y.—Roads, streets and pavements, 4th year.

Rensselaer Polytechnic Institute, Troy, N. Y.—Road engineering; bituminous road materials; asphalt road construction.

University of North Carolina, Chapel Hill—Highway engineering, double course, fall and spring quarters.

North Carolina State College of Agriculture, West Raleigh—Highway engineering, methods and materials, 2 periods a week, 2d term; highway engineering, economics, surveys, plans and estimates, 1st term, 2 periods a week; highway engineering, foreign natural and state road systems, etc., 2d term, 2 periods a week; highway engineering, laboratory, 2d term, 2 periods; highway surveying, field work, 1st term, 2 periods a week.

North Dakota Agricultural College, Agricultural College—Roads and pavements, spring term, 4 credits; roads, spring term, 2 credits.

University of North Dakota, University—Municipal engineering, 4 credits, 4 hours a week, first half of semester and last half of second semester.

Ohio Northern University, Ada—Course in roads and pavements, etc.

Municipal University of Akron, Akron, Ohio—Materials, laboratory, standard tests for paving brick, etc.

University of Cincinnati, Cincinnati, Ohio—Highway engineering, theory; highway engineering, design.

Case School of Applied Science, Cleveland, Ohio—Highway engineering, junior year, first term, 3 hours per week; highway engineering, advanced course, senior year, second term, 14 weeks, 4 hours per week, lectures, recitations and laboratory.

Ohio State University, Columbus, Ohio—Roads and pavements, 3 credit hours, second semester, 3 recitations a week, third year. Short winter course in highway engineering includes, among other general civil engineering subjects, road economics and maintenance, road-building machinery, roads and streets, sanitary pavements, etc.

University of Oklahoma, Norman—Roads and pavements, 4 hours; roads and pavements, advanced course, 4 hours; highway engineering, research and experimentation, 4 hours.

Oklahoma Agricultural and Mechanical College, Stillwater—Rural roads, 1 hour class, 4 hours laboratory; roads and pavements, 2 hours class; testing road materials, 3 hours laboratory.

Oregon Agricultural College, Corvallis—Roads and pavements, junior year, first term, 2 credits, 2 recitations; roads and pavements, continued, second term, 3 credits, 2 recitations, 1 laboratory period; highway engineering, senior year, first term, 4 credits, 2 recitations, 2 laboratory periods; highway engineering, continued, second term, 3 credits, 2 recitations, 1 laboratory period; highway engineering, continued, third term, 4 credits, 2 recitations, 2 laboratory periods; highway transportation, senior year, 3 credits, 3 recitations; municipal engineering and city planning, senior year, third term, 3 recitations; economics of highway construction, senior year, 1st term, 3 credits, 3 recitations. Graduate Course in Highway Engineering—Road design, 2 periods a week; construction

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of roads, 3 periods a week; highway bridges, 3 periods a week; cement and highway laboratory, 3 laboratory periods a week; street design and construction, 3 periods a week; reinforced concrete highway structures, 3 periods a week; contracts and specifications, 2 periods a week; hydraulics of highway drainage and construction, 1 laboratory period a week.

Allegheny College, Meadville, Pa.—Highway surveying, 2d term, 3 hours; road construction and maintenance.

Lafayette College, Easton, Pa.—Roads and pavements, first term, 3 credit hours, 2 recitations and 1 three-hour laboratory period per week.

Bucknell University, Lewisburg, Pa.—Roads and pavements, second term, 5 hours.

University of Pennsylvania, Philadelphia—Roads and pavements, 1st term, 2 hours.

Carnegie Institute of Technology, Pittsburgh, Pa.—Highway engineering; materials.

Temple University, Philadelphia, Pa.—Highway engineering, 2 hours lectures or recitation, 1st semester, 3 hours drawing, 2d semester; construction (includes streets, design, pavements, etc.).

University of Pittsburgh, Pittsburgh, Pa.—Roads and pavements, junior year, spring term, 2 lectures and 3 hours design per week; highway materials (testing laboratory), 1 lecture and 3 hours laboratory per week; roads and pavements, senior year, 2d semester, 1 recitation and 3 hours laboratory per week.

Lehigh University, South Bethlehem, Pa.—Construction, including streets and highways, etc.

Pennsylvania State College, State College—Highway engineering, junior year, 2d semester, recitations 2 hours, 2 credits; highway materials, laboratory, junior year, 2d semester, practicum 2 hours, 1 credit; tests of road materials, senior year, 1st semester, practicum 2 hours, 1 credit; highway design, senior year, 1st semester, practicum 5 hours, 2 credits; highway design, continued, 2d semester, practicum 6 hours, 2½ credits; highway engineering and land drainage, junior year, 1st semester, practicum 5 hours, credit 5 hours.

Swarthmore College, Swarthmore, Pa.—Municipal engineering, 2 hours, 2d semester.

Villanova College, Villanova, Pa.—Highway engineering.

Rhode Island State College, Kingston—Roads and pavements, 3 recitations, credit and 1 field credit, 2d term.

Brown University, Providence, R. I.—Highway engineering, 3 hours, 2d or 3d term.

Clemson Agricultural College, Clemson, S. C.—General civil engineering, course for seniors; attention given to modern highways and city streets.

University of South Carolina, Columbia—Highway construction, special two-year course; civil engineering (2), roads and pavements, lectures and recitations, 1st term.

University of South Dakota, Vermillion—Roads and highways, 1st semester, 3 hours, 3 credit hours.

South Dakota State College of Agriculture and Mechanic Arts, Brookings—Highway construction, 1st semester, 2 credits.

South Dakota State School of Mines, Rapid City—Roads and pavements, senior year, 1st semester, 3 lectures a week.

University of Tennessee, Knoxville—Highway engineering, 1st term, 3 recitations and 2 problem periods; highway bridge design, 2d term, 2 periods; highway engineering, organization of highway departments, etc., 2d term, 3 hours; design of highway bridges, 2d term, 3 design

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periods. Short Course for Highway Engineers—Mathematics (algebra, geometry, and trigonometry), review, 6 weeks; drawing, 6 weeks; materials testing, non-bituminous, 6 weeks; materials testing, bituminous, 6 weeks; elements of mechanics, 6 weeks; highway field engineering, 6 weeks; highway design and construction, 6 weeks; quantities and costs, 6 weeks.

Vanderbilt University, Nashville, Tenn.—Municipal engineering, 3 hours.

University of Texas, Austin—Highway engineering, location, construction and maintenance; highway engineering, including specifications and contracts; highway laboratory; highway bridges, especially for country purposes; advanced highway engineering.

Agricultural and Mechanical College of Texas, College Station—Roads and pavements; highway construction and maintenance; highway materials; bridge design, steel highway bridges; highway bridges and culverts; highway laws and economics.

Rice Institute, Houston, Texas—Municipal engineering.

University of Utah, Salt Lake City—Highway construction.

Agricultural College of Utah, Logan—Road construction, fall quarter, 5 hours, 5 credits; road maintenance, winter quarter, 5 hours, 5 credits; roads, materials, winter quarter, 3 hours, 3 credits; canal and road surveying.

University of Vermont and State Agricultural College, Burlington—Highway engineering, 4 hours, 2d semester.

Virginia Agricultural and Mechanical College and Polytechnic Institute, Blacksburg—Highway engineering, 1st term, 3 times a week.

University of Virginia, Charlottesville—Roads, streets, street railways, spring term; road materials testing, spring term.

Virginia Military Institute, Lexington—Highway engineering, roads and pavements, 3 hours a week, 1st term; design of highway and railroad bridges, 3 hours a week, 2d term.

Washington and Lee University, Lexington, Va.—Highway engineering. Three courses provide instruction in location of highways, the establishing of grades, the computation of earthwork, construction of roadbeds, and their proper maintenance. Short courses of two terms in highway surveying, design, and construction.

State College of Washington, Pullman—Highway engineering, 3 hours, 1st semester; advanced highway engineering, 2 hours, one recitation and 3 hours laboratory per week, 1st semester; concrete arch highway bridge, design of, 2 hours, 2 hours preparation and 4 hours drafting per week, 1st semester; country roads, 2 hours; highway laboratory.

University of Washington, Seattle—Highway, 3 credits, 3d quarter; roads and pavements, 5 credits, 1st quarter; field practice in survey and construction of highways, railroads, canals, etc., 4 credits, spring term.

West Virginia University, Morgantown—Roads and pavements, 3 hours, 1st semester; highway economics, 2 hours, 2d semester; highway laboratory (credit varies).

University of Wisconsin, Madison—City planning, 1st semester, 2 credits; city planning, 2d semester, 2 credits; country roads, 2d semester, 1 credit; introduction to construction and maintenance, 3 credits; advanced economics, designs, estimates, inspection trips, 2d semester, 3 credits; analysis of highway bitumens, 2d semester, 2 credits (included in the following course); testing road materials, 2d semester, 3 credits; highway bridges and culverts, 2d semester, 2 credits.

Marquette University, Milwaukee, Wis.—Highways, 3 credits per week.

University of Wyoming, Laramie, Wyo.—Roads, 1st semester, 2 credit hours; testing materials, 2d semester, 2 credit hours.

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HIGHWAY SIGNS AND MARKERS

Sign-posting the highways with direction signs and danger signals of uniform standard and design has become a national necessity by reason of the tremendous volume and wide travel radius of motor traffic. In a day's journey the motorist may cross many jurisdictions. It is necessary not only for his safe and convenient travel that there should be uniformity in sign-posting, but also for the safety of those motorists whom he may encounter.

Much has been done in the way of investigation of the problem as a whole and definite steps have been taken by individual States, but a national or coördinated policy is yet in prospect.

Intelligent sign-posting and marking of highways aid the traveler, local or foreigner, in finding his way on the country highways and through the cities; aid him to travel with safety to himself and others; inform him of traffic rules and ordinances, the whereabouts of places and objects of practical scenic or historic interest, and assist in the proper care and management of the highway.

Highways outside of municipalities now form two distinct classes, State and local. Soon we hope there will be a third class, national highways. As State highways are usually the most heavily traveled main roads, it is desirable that they be marked with a symbol to distinguish them from local highways. This is of benefit not only to the traveler but to the authorities in charge of the highways.

Just as streets in cities have names and numbers, so the highways should have distinct names and numbers, preferably names, because they are more expressive and more easily remembered, and if carefully selected help to teach history. Direction with reference to points of the compass might easily and with benefit be shown by suitable symbol or color, preferably color.

When a highway enters a town or city and takes up its course on the other side, it is highly desirable that the route through the town or city be shown by suitable symbol or marker. It is equally important that main roads routed around instead of through cities should be suitably marked.

Every point on the highway that might be dangerous to the traveler should be so posted as to give him warning, ample in time and specific in character, and all cautions which public welfare demands should likewise be set up.

Coördination to the end that the same symbol should mean the

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same thing in all jurisdictions is vitally essential in these days of enormous travel, as otherwise disaster instead of safety might be precipitated. In order to facilitate travel at night as well as in daytime, uniformity in the location of signs and in their height from the ground, so as to accustom the traveler to look in an established direction and at a given height for sign instructions, is highly necessary.

Structural and operating questions as to the durability of signs and posts, protection from destruction or obliteration by the elements and vandals, legibility of instructions, simplicity and attractiveness of designs and cost of installation and upkeep must engage attention. Jurisdiction and regulation must be provided for purposes of protection, coordination and the elimination of objectionable signs and advertising matter.

At the First International Road Congress, held in Paris in 1908, much attention was paid to the subject of sign-posting the highways. The Congress expressed its desire that a general and uniform plan of highway posting be adopted for each country. Certain specific recommendations were made, viz.: 1. That distance be marked beginning from large towns on roads radiating therefrom; 2. That a uniform model for all milestones be used, and that inscriptions be few and very legible; 3. That a uniform method of calculating distances be adopted; 4. That administrative information on signs be limited as much as possible; 5. That a system of warning signals representing the kind of danger and including its name be used; 6. That the number of signals be limited to four: (a) obstructions, (b) corners, (c) grade crossings, and (d) dangerous crossroads; and 7. That danger signals supplied by private bodies approved by the authorities, and under their inspection, should belong to the highways and have protection of the law.

At the Second International Road Congress, held in Brussels in 1910, the following recommendation was made by Theo. Bradaczek of Prague with reference to color markings indicating direction: That the color marking for a road running east and west be red; north and south, blue; northwest and southeast, green or violet; and northeast and southwest, yellow. He also recommended that these colors be used on the signs themselves as well as on the road maps, and that where the road is interrupted by that of another road that the system of double marking should be so employed on the intervening road as to indicate the continuation of the road beyond the interruption. Apparently no action was taken by the Congress on this recommendation, but certainly some scheme of this kind would be very desirable,

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especially if supplemented by arrows and symbols indicating orientation.

Considerable progress has been made in the last year or so by a few of the States in marking and sign-posting the highways. Wisconsin has probably made as great progress in marking and sign-posting its highways as any other State. A description of the Wisconsin system, prepared by J. T. Donaghey, Maintenance Engineer of the Wisconsin Highway Commission, is as follows:

In placing the trunk highway law upon the statutes of Wisconsin, the legislature of 1917 provided that after designating a 5,000-mile system (later increased to 7,500 miles) the commission should mark the roads with some standard design. The commission decided to use numbers rather than names. In order to standardize the marker, two digits were used. The numbering, therefore, begins with "10," the longest continuous highway in the State carrying the number "10," the next in length "11," and so on until the shortest highway on the system carries the number "78." It was also decided to place mile posts on each trunk route, beginning at the south end of the line and extending in a northerly direction, and at the east end of the line, extending in a westerly direction, the numbers being consecutive from "1" to the required number for the entire distance. Signs are placed on county lines and at the limits of each patrol section, giving direction where necessary, and warning against dangerous places.

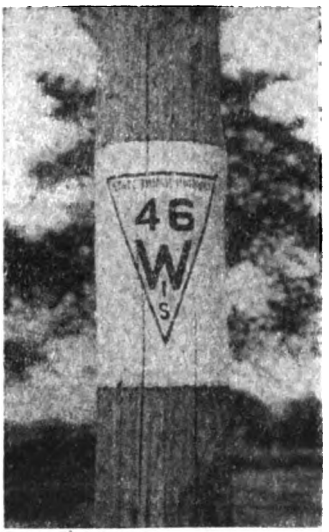


Fig. 1

Figure 1 shows the standard design selected. It consists of a triangle 10 inches wide at the top and 13 inches deep, carrying the words "State Trunk Highway" at the upper edge and in the lower part of the triangle "Wis." Markers are placed on telephone posts where convenient, and on special posts erected where necessary; also, on other objects permanently located.



Fig. 2

Turns in the road are noted by placing an "R" or "L" immediately under the point of the triangle, indicating "right" or "left." A white band 18 inches deep is painted around the pole with two coats of white lead and oil before stenciling the design in black. The white band is a distinctive mark itself, as it may be seen from a considerable distance. Where "R" or "L" is to be used the white band is 20 inches wide. The

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marker is placed on the pole at a point as nearly as possible on a level with the eye when standing in the middle of the roadway. The marker is stenciled on both sides of the pole, facing traffic from either direction. Where the trunk line intersects another highway, but does not turn, a marker is placed on the first telephone pole on either side of the road intersection facing the traffic. Where two or more trunk lines follow the same route for a short distance, both markers are stenciled on the poles.

Figure 2 shows the standard mile-post edgewise to the road with the standard marker stenciled upon each side. Mile-posts are placed just outside the construction and maintenance limits. Mile numbers are placed about two inches below the point of the triangle. These mile numbers are primarily for convenience in tabulating maintenance and construction progress reports, but are also of interest to the traveling public.



Fig. 3



Fig. 4

Figure 3 shows the standard county-line sign with the standard patrol section sign attached to the same post. The county-line signs give the name of the county and the county highway commissioners, showing who is responsible for the maintenance of the entire system in each county. The patrol section signs contain the name and address of the patrolmen, thus enabling the public to know exactly who is in charge of each section and to whom to appeal for immediate relief, if any defect or dangerous place appears in the road. The patrol section signs are placed at the end of each section.

Figure 4 shows the standard direction signs placed at important road intersections, directing the traveling public to towns along the trunk high-

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way system. Similar signs are placed where traffic should leave the trunk system for important towns off the system.



Figure 5 shows one form of the standard danger sign, which is 20 inches wide at the top and 24 inches in depth. A similar sign is used at dangerous railroad crossings and at dangerous curves, substituting the words "Railroad Crossing" or "Curve" for the word "Hill." The signs are located about 400 feet in advance of the dangerous place. "Slow" or "Caution" signs are placed near schoolhouses, churches, or other places where there is no extreme danger, but where care should be exercised.

The trunk highway law also provided for the commission to publish a map each year, corresponding to the marked system, and to be sold to the public at not less than 10 cents per copy. Any persons wishing to visit any town in Wisconin by auto at the present time may easily reach the desired point without asking one question.

The Michigan System.—Frank F. Rogers, Highway Commissioner of Michigan, recently wrote to Capt. W. S. Gilbreath, manager of the Detroit Automobile Club:

I have made a very careful study of a number of the different systems of marking. Among these, that used by Wisconsin has attracted my attention. I have worked out a system of numbering very similar to Wisconsin and intend to mark the State trunk lines with a diamond-shaped stencil with black lettering on a white background. It is possible, too, that some mile-posts may be arranged for. It is our intention to have poles set up, keeping these signs close enough together to clearly mark the trunk lines, thus making it possible for any one to follow them with the aid of a map which the State will have published showing the roads and the numbers thereof. Stencils have been ordered and are being prepared for distribution to the counties, to the end that this marking will be done this fall (1919).

The Ohio System of Marking.—In July, 1919, the State Highway Department of Ohio addressed a communication to all county authorities in regard to the numbering and marking of intercounty highways in that State. The following is quoted from that communication:

Enclosed you will find a print showing the method of numbering intercounty highways; also instructions for doing this work. You will observe that they have been called "State Routes," as it seemed impracticable to put the long term "Intercounty Highway" on the small space available. It is desired that you number all of the State roads as per enclosed instructions. * * * We believe that the cost of this work to the counties will be so small that they will not find any objection to having it done. The department has had made a number of stencils for putting on the lettering and the outline of the State, and these will be furnished the county upon request, with a statement that they have the poles painted with two coats of white paint as called for in the instructions. * * * It is desirable, of course, to have the most important routes numbered first, and if all of the routes cannot be numbered in the near future, this need not hold up the work on the most important thoroughfares. * * *

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The detailed manner in which the State Highway Department has gone into the uniformity of marking is shown by the following supplementary communication to county road authorities:

The numbers will be placed on telephone or other poles (except where other arrangements are necessary) by painting a strip completely around the pole 18 inches wide with two coats of white lead and oil. After the second coat of paint is dry, there is to be placed upon this white band an outline map of Ohio, inside of which shall be the wording, "State Route" at the top and "Ohio" at the bottom; between these will be the number of the road. The total width of the sign is 13 inches; the height of the lettering of "State Route" one inch. The height of the figures representing the road number, 5 inches, and the height of the letters of the word "Ohio," 1¼ inches. The outline map and the lettering are to be placed on the pole by the use of stencils and shall be made with black paint upon the white background. * * * The numbers of the county roads should not be posted in such a way as to confuse one with the numbers of "State Routes."

The road number is to be so located on the pole as to be most easily read by one traveling along the highway. The number is to be located at such height that it will be at about the height of the eye of a person riding in a machine on the highway. At the same time, care must be taken in placing these numbers to see that other legitimate numbers on the poles, such as those placed there by the company owning the poles, be not obliterated. These numbers shall be placed along the intercounty highways at least no farther apart than every half mile, and at more frequent intervals if it be necessary to indicate to the traveler whether he is continuing on the same or another road. It frequently will be necessary to have a number placed on the first pole on either side of a cross or intersecting road. In case the "State Route" turns to the right or left from a road which continues its direction, the letter "R" or "L" will be placed underneath the sign to indicate the direction which the "State Route" takes.

The Ohio Highway Department has recognized the importance of uniformity in the marking of danger spots. In connection with the posting of these uniform signs over the State, the Deputy Highway Commissioner writes: "These signs are to serve as a pre-warning of danger zones and are to be erected along the road at the outer edge of the shoulder about 200 feet back of where the danger zones begin. The signs should not be promiscuously used, and they should be erected only where there is a place of real danger, as this will result in their being of most value."

These Ohio danger signs are practically the same as those recommended by the American Automobile Association.

The New York System.—The following extract is copied from a recent report of the New York Commissioner of Highways for that State:

The ever-increasing use of public highways, especially by motor vehicles traversing considerable distances, makes necessary the installation of direction and distance sign-posts. It is believed that such installation

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should be included in all contracts for new construction, and in maintenance contracts when not provided in the original contracts. All State roads should have well-designed concrete or stone mile-posts of uniform size and form.

The inscription on the side of the stone toward the approaching traveler should state the name of and the distance to the terminal of the State road toward which the traveler is going. There should also be small concrete stones to mark each tenth of a mile for the use and convenience of engineers and inspectors who may thus more readily locate and direct repairs.

All State and county roads should have three classes of elevated signs: (a) distance and direction signs; (b) police and warning signs; (c) warning symbols. Each class of elevated signs should, as far as possible, be uniform in material, size, form, color, height, distance from edge of road, and location with respect to the indicated topographical features, and should be indestructible as far as possible.

Distance or direction signs in villages should contain four lines: 1. Name of village where sign is located, in black letters not less than 2½ inches high; 2. The nearest main terminals of the road and the distance to these in each direction, in 2½-inch block letters; 3. The nearest principal points on the road and the distance to these in each direction, in 2½-inch block letters; 4. The nearest minor points on the road and the distance to these in each direction, in 2½-inch-high block letters. Distance and direction signs outside of villages should contain three lines, similar to the three last described.

Warning signs and symbols should be placed on State and county highways wherever necessary to call attention to danger and to legal requirements.

The Connecticut Plan.—Connecticut has laid out for improvement wholly by the State a system of 14 trunk lines which it is planned to route mark when completed. For the present this marking is confined to the roads fully or practically completed and to those adjoining marked improved roads in neighboring States.

In connection with other New England States, a color system of designating these through routes was adopted. As a preliminary the entire trunk-line system was charted so that as the work progressed each marked route would form a part of the completed whole. The adopted system is tri-color, red designating east-and-west routes, blue north-and-south routes, and yellow diagonal or secondary routes, thus conforming to the system adopted by Massachusetts, Rhode Island and New York. Care has been taken that the marked lines in Connecticut shall connect with those of adjoining States, so that the tourist will have continuous lines of well-defined interstate trunk highways.

The markings consist of bands of color on telegraph and other poles, 10 inches in width, on a white background 14 inches in width, and placed at a height easily visible to the driver from all directions. On continuous lengths of road without intersections, bands are placed only at intervals of about one mile. At inter-

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secting roads the second pole on either side of the intersection is banded, so as to clearly direct travel along the main route.

Where two routes of different colors intersect, the pole at the junction is marked with a band of each color, the second pole on either side of the intersection, as before, being marked with a single band. In several locations throughout the State it has been found that travel will be better accommodated by carrying two route colors over the same section of road where both north-and-south and east-and-west routes occupy the same highway for short distances. In this common section, bands of both colors appear for such distance as these routes coincide.

This system of color bands is reinforced with arrow direction markers mounted on 4 x 4 posts at main intersections. These markers are 7 inches in width enclosing an arrow 5 inches in width of route color. The name of the next large town is superimposed upon the arrow in 4-inch letters.

In connection with the route marking, a complete map of the road system of the State has been published, designating those roads which have been color-banded by corresponding colors on the map.

Danger signs are also erected where necessary. The standard signs already adopted include "Railroad," "Steep Grade," "Sharp Curve," and "Cross Road." These are 24 x 36-inch size and carry a symbol which is readily recognized, in addition to the warning.

The South Carolina System.—In South Carolina each of nine trunk-line highways have been designated by number and are marked with color bands, each road having a different color scheme, as follows: No. 1, Appalachian Highway, red and white band with the letter "A" superimposed; No. 2, Old State Road, blue and white band, letter "S"; No. 3, New York-Florida Highway, red, white and blue, letter "W"; No. 4, Piedmont Highway, green and white, letter "P"; No. 5, Carolina Highway, red, white and orange, letter "C"; No. 6, Coast Highway, black, white and orange, letter "G"; No. 7, Pee Dee Highway, green, white and orange, letters "P. D."; No. 8, Trans-Montane Highway, black, white and red, letter "M"; and No. 9, National Highway, red, white and blue, with the letter "N."

Several years ago New Hampshire adopted a system of marking the State trunk highways by means of color bands on telegraph poles. As each State road has been completed its course has been marked by a new color. The color scheme, however, does not indicate orientation as in Connecticut and Massachusetts.

Mr. George C. Diehl, chairman, A. A. A. Good Roads Board,

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Buffalo, N. Y., has given considerable attention during the past few years to the question of road signs. The following is quoted from a recent communication from Mr. Diehl on this subject:

The first step in any comprehensive plan of road signing must be the naming of all roads; this is of the utmost importance. Incidentally, in Erie County we have a map which shows the name of every highway. This is of considerable importance on side roads, as usually farmers have half a dozen different names for the same road, and in this way we have made it possible to designate definitely various road improvements. As a general proposition, the roads should be named to show that they are national, State or local in character. For instance, a national road should be called the "New York-San Francisco Highway," the "Quebec-Miami" or the "Lincoln Highway"; State roads should be called the "Philadelphia-Pittsburgh," "New York-Buffalo" highway, etc.; and local roads could be named, as at present, the "Mineral Springs Road," "Bowen Road," etc., generally after people's names.

It is comparatively easy to get the roads named, as nearly all the States have State highway commissions, and it would be merely necessary for the highway commission to designate the State roads and then call upon the appropriate county official to name the remaining roads, and by co-operating with the U. S. Department of Agriculture names could be given to the more important of the national routes. While this might appear to be rather a long-winded proceeding, yet it is necessary before a permanent system of road-signing can be adopted.

One of the towns (townships) in Erie County has designated the names of all roads by cast-iron signs placed at every road intersection, so there is no difficulty in getting from one road to another. Eventually this will have to be done in all the towns, although this is the only one that I know of that has now done so.

The signs along roads of national importance should be quite elaborate affairs, particularly at the more important junctions. Generally speaking, they should be of concrete or masonry construction, 6 or 7 feet high, and possibly 3 feet square, and of artistic design, the information being placed on a metal plate embedded in the masonry work. This plate should contain the name of the road, the name of the township, village or city, the names and distances of the termini of the highway, the name and distance of the largest city on either side of the sign-post, and the name and distance to the next place on either side. The distance and direction to the next point of historic interest should also be given, such as "78 miles to Gettysburg Battlefield," "320 miles to the Grand Canyon of Colorado."

The marking of State highways should be along the same general lines, except that the posts would be less elaborate, preferably concrete posts with metallic or wooden signs. Special signs should be erected at points where unusual views could be obtained, with information pertaining to the particular location. This could be done similar to the marking at "Inspiration Point" in the City of Denver, where a plaza has been constructed where motorists can drive and signs point to the various high mountain peaks, such as Pike's Peak, Long's Peak, and others.

The sign-posting work has been a good deal of a makeshift up to the present time, and probably the program as outlined is rather too elaborate at present, but some such idea should be the goal of all sign-posting, and we should get out of the habit of nailing unattractive wooden pointers to trees and telegraph poles, and begin the more permanent work.

If we are to make the highways safer and more inviting, it is necessary to get the people into the habit of driving slower to look at the

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scenery and become more familiar with the territory through which they are driving, and I believe one of the most desirable ways to accomplish this is by having attractive, accurate and descriptive road signs.

A committee of the American Road Builders' Association, composed of R. A. Meeker, L. J. Bauer and T. J. Wasser, recently made a report to the association on the subject of uniform highway signs. The recommendations of this committee are as follows:

The committee on uniform highway signs would respectfully report that it has carefully considered the question of a modification of their recommendations embodied in its preliminary report and have as a consequence prepared a final report and present the same to the A. R. B. A. for its consideration.

The radius of travel in the past ten years has increased from fifteen to one hundred and fifty miles, hence the need for clear, distinct and uniform highway signs is ten times greater today than it was ten years ago. The direction sign must be large enough to carry lettering that can be read at a distance of at least 200 feet. The letters must be plain, widely spaced and the contrast between the letters and the background must be strong, so that the name will stand out clearly. As the average rate of travel is 30 miles per hour in the open country, it is necessary that the lettering be large and clear enough to be easily read at that speed.

The precautionary sign should be of sufficient size to permit of wider spacing than that on the direction sign, and symbols are found to be more quickly discernable than words. The word "Danger" alone is not sufficient, because the traveler wishes to know at a glance what the particular object to be on guard against is: to make this more clear we have adopted a bent spear with a red head pointing in the direction of the sharp curve. The other signs remain unchanged.

The committee on uniform highway signs would therefore commend that, in view of the fact that there is a need and demand for the proper marking of the highways of the country, the sign of the State of Connecticut as further modified be adopted as a standard and that the arrow plan for direction markers be followed, with the name of the most important town on the route shown in a conspicuous place within the arrow, and the two next intermediate towns placed in a less conspicuous place on the sign.

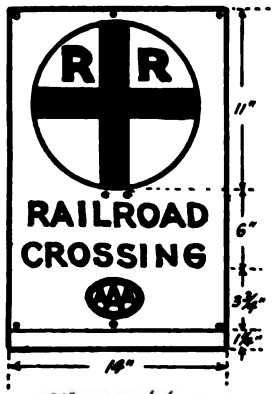
First—The direction marker to be 15 inches high by 36 inches wide; the sign to be constructed of either wood or metal; small arrows to be shown in front of the names of the two towns or cities shown above the main arrow; a system of coloring to be adopted showing the main and secondary routes, viz., black posts for north and south, white posts for east and west, these colors forming a ground for any symbol that a particular State may adopt for its main and secondary routes. Where these signs are located in a town, there shall be added on top the words "This Is ————," giving the name of the town.

Second—The precautionary sign to bear the word "Danger" in permanent red at the top and beneath the proper symbol for curves, railroad crossing and grade steeper than 7 per cent, with the distance in feet to the impediment, which shall be, wherever possible, 500 feet.

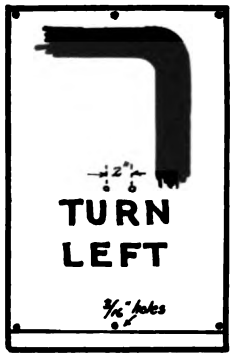
All signs shall be supported on posts of either wood, iron or concrete, and shall not exceed 7 feet in total height above the ground.

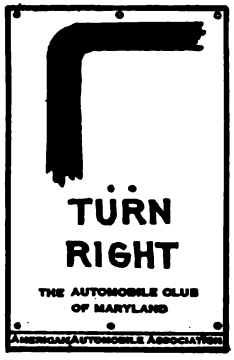
It will be seen from the above that considerable progress has

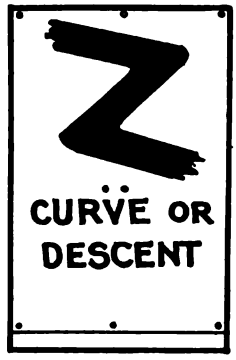
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20" gage metal
Chrome yellow background
Black figures and letters





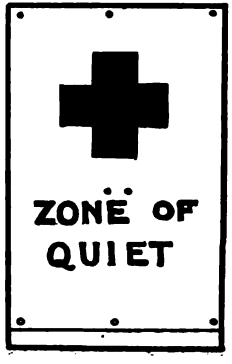


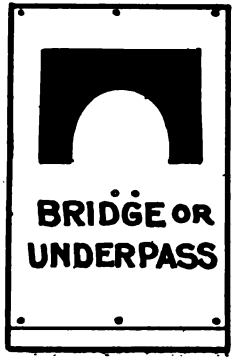


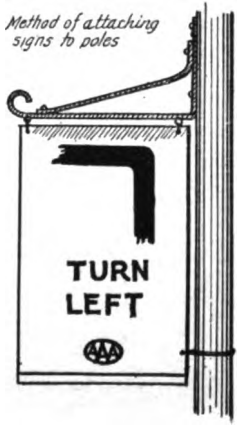
A. A. A. International Road Signs











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been made in standardizing highway signs and danger signals and in sign-posting the highways in some of the States, yet much remains to be done, as very few States have, up to the present time, given this matter any very great consideration. Furthermore, there does not appear to be any effort on the part of the various State to have their systems so correlated as to facilitate travel from one State to another. It would seem rather that there is a tendency on the part of the States to adopt their own system and have it as much unlike the system in other States as possible, with the possible exception of Michigan and Wisconsin. For that reason, it would seem desirable that either the State highway departments or the officials of the various national highway organizations should get together with the idea of studying what has been done in the different States and foreign countries and if possible work out a scheme by which road signs and danger signals could be more or less standardized for all States.

The American Automobile Association has adopted the recommendations of the International Road Congress held at Paris with reference to the four danger signals above referred to, and has added four other signals, which have been found to be practical and to meet existing conditions in this country. These signs are at present as follows: 1. Railroad crossing; 2. Left turn; 3. Right turn; 4. Dangerous curve or descent; 5. Cross roads; 6. School house; 7. Extreme danger; 8. Zone of quiet; 9. Dangerous bridge or under-pass. These are indicated in the accompanying cuts.

The great advantage of this code is that it is self-explanatory. Each sign indicates by text and signal what the danger is which the motorist is to avoid. Any one can tell at a glance without bringing his car to a stop what each of the signs means when met with on the road. The colors adopted are chrome yellow and black, preferably using the former color as a background, and this combination is more readily distinguishable at night. Railroads throughout the country have selected these colors for track signals.

The American Automobile Association, through its local clubs, is constantly urging the use of these signs and from the degree of success already attained it is believed that they will ultimately come into general use throughout the country.

For several years the Association has also urged the general adoption of the information or direction signs which indicate the name, mileage and direction by means of an arrow of the most important town on the route and two or three of the next intermediate towns, including the nearest town. These signs usually include the name of the local club responsible for their erection.

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ROADSIDE PLANNING AND PLANTING

Scientific and practical roadside planning and planting calls for such a combination of forestration and aesthetic considerations as will protect and preserve the highway, increase the safety and comfort of the traveler, and further the beautification of thoroughfares.

The question concerns not alone the planting of trees and shrubs, but in many cases just the reverse. It includes the protection of slopes from erosion and unsightliness by the planting of grasses, vines, and shrubs; relates to the elimination of danger at curves and crossings by cutting away heavy foliage; has to do do with the elimination of objectionable advertising signs; and requires the protection of shoulders and rights of way by the cutting of weeds and underbrush and by suitable and artistic planting. Furthermore the consideration of such collateral questions as the establishment of public campsites and roadside parks must not be overlooked.

This subject has received comparatively little attention in the United States. On most of the roads the right of way outside the ditch lines is "No Man's Land." This has not been due to ignorance or wilful neglect, but rather to the fact that all available energy and funds have been used to provide suitable grades, drainage, bridges, and road surfaces. With nearly 7,000,000 automobiles and over 25,000,000 motor car users in this country, the time has come when the aesthetic tastes of road travelers should have some consideration.

The drift of population from country to city, which during the past generation has reached alarming proportions, must now be checked, and among the most effective measures to this end is the building and beautifying of our country roads. The highway must no longer be considered as a mere link between communities. It must be made a thing of charm in itself.

A movement is now on foot looking to the planting of trees as memorials to our heroes who gave up their lives "somewhere in France' and on Flanders fields. One cannot conceive a more appropriate memorial than trees which grow more stately and impressive year by year and every spring take on the fresh green of new life. If individual trees are fitting memorials, how much more impressive would be a long vista of tree-lined highway extending where earth and sky blend. A happy union of highway and trees as a memorial to the dead and a pleasing utility for the living should find quick and generous indorsement.

Europe has paid far greater attention than America to beau-

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tifying highways. The charm of travel through England's bowered country ways and the trim neatness of Routes Nationale in France and the highways that pass through fields of poppies in Flanders linger most pleasantly in the memories of touring Americans.

Inquiries were recently sent by the American Automobile Association to the State highway departments of the various States, with the idea of ascertaining what had been done and what was the attitude of officials with reference to roadside planning and planting. Replies were received from all the States except eleven. Of the replies received nearly all officials indicated their interest in the subject.

A few noted objections to tree planting. Engineer Johnson of Nebraska indicated that his State is not encouraging the planting of roadside trees, but is cutting them down in rights of way and encouraging cutting along the fence lines. In his opinion, it is impossible to keep the roads open through the winter because of snow drifts where there are trees. Highway Commissioner Wright of Indiana thinks too much land would be wasted by tree planting along highways. He is, therefore, opposed to the proposition. Acting State Highway Superintendent Sevison of Wyoming expressed a willingness to coöperate, but calls attention to the difficulty of growing trees by the roadsides in the semi-arid regions of the West through the lack of water. Former State Highway Commissioner Cowan of Ohio stated that the narrowness of most of the existing rights of way in his State precludes the possibility of tree planting until the farmers can be induced to move their fences off the rights of way.

Several State highway departments relate that steps have already been taken looking to the planting of trees. Engineer Duren of Texas writes that the legislature has adopted the pecan as a State tree and has requested the highway commission to encourage its planting along State highways, which it is doing. State Highway Commissioner Everett of New Hampshire refers to the fact that the highway department has coöperated in the planting of trees along State roads, the forestry department furnishing the trees and the road patrolmen looking after the planting.

Massachusetts apparently is the only State which has made any great headway in tree planting, former Chairman Sohier of the State highway commission pointed out in his reply that there has been activity for many years and that it is considered very valuable work. He submitted interesting statistics showing the results accomplished as early as 1894, but indicated that real tree planting did not begin until 1904. In that year 4,907 trees

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were planted at $1.14 per tree. The work has been continued from that time and nearly 21,000 trees have been planted in 10 years.

The simplest and most essential form of roadside treatment consists of clearing away the rubbish, underbrush and weeds, leveling up the shoulders and slopes, and keeping the ditches and culverts clean.

Sodding or planting grass on shoulders and slopes of embankments, and, when possible, those of cuts, not only pays for itself in the protection it affords those important parts of the road against erosion, but in the improved appearance which it imparts. Such treatment adds greatly to the pleasure of travelers and encourages dwellers along the road to beautify their grounds by the planting of flowers, shrubbery, and trees.

All brush and embankments or other obstructions which obscure the vision on the inside of sharp curves, on the approaches to railroad crossings or other dangerous places, should be removed. The natural forest growth should be cut back if necessary to improve the line of site.

Telegraph and power poles are unsightly, and, if left in the road bed, as at present in many places, they constitute an actual menace to traffic. All such obstructions should be moved from road beds, shoulders, or side ditches, or wherever they are so located as to obstruct traffic or vision.

From the aesthetic standpoint, there is the question of accentuating rather than masking natural beauties and interesting spots along the road and of masking or modifying unattractive features. The hideous advertising signs which seem so out of place in a peaceful landscape require careful regulation, for billboards add no beauty and provide no shade. They often cut off the view of attractive landscapes and obscure the line of sight on the inside of sharp and dangerous curves. The really essential road signs, however, indicating direction or danger should be accentuated rather than modified by the treatment of the roadsides.

The fundamental principles of landscape architecture are: 1, plant in masses; 2, mass color schemes; 3, avoid straight lines; and 4, preserve open spaces. While these principles cannot always be put into practice on a narrow strip of highway, they can be used effectively on private estates and tracts of land abutting on important roads, in roadside parks and with campsites.

The planting of attractive trees, shrubs, vines, and perennial flowers constitutes an important phase of roadside treatment. The essential need is to produce shade, protect from wind and snow, and at the same time produce a picturesque and pleasing

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appearance. In all such planting, however, local conditions should be considered and the advice of a competent highway engineer, and, if possible, a landscape architect or an expert on flora culture, should be followed. Sporadic efforts of individuals and clubs without adequate knowledge of road, forestry, or landscape conditions are apt to do more harm than good, for the planting should be done in accordance with plans properly thought out and the varieties should be selected by those who are thoroughly familiar with trees, shrubs, and plants and the effects which they produce upon the road and the adjacent landscape.

The planting of trees and shrubs if properly carried out constitutes an important factor in the preservation of the road, especially certain types of surfacing such as macadam and gravel, as the trees prevent the surface from drying out too rapidly and of becoming dusty. Trees break the force of the wind and rain in their destroying effect in carrying off the binding material. They tend to keep the road at a more uniform temperature, preventing frequent and rapid freezing and thawing, which are harmful to the higher classes of pavement.

When determining upon the kind of roadside treatment to be adopted, consideration should be given to the protection of the road from snow drifts in sections of the country where the snow fall is heavy. A study of the relative positions of snow drifts, the direction and velocity of the winds, and the relative location of the road would aid in determining what course to pursue; for example, whether trees or hedges would be most advisable, and, if trees, what kind should be used; if hedges, the kind and height, location and method of planting.

In the selection of trees for roadside planting many kinds may be considered. The trees should be hardy, grow rapidly, and produce an abundant well-shaped foliage. Wherever practicable, trees of local origin should be used, as they are more easily obtained and known to be adapted to soil and climate. A great variety of conditions exists in the United States, and it would be impossible to designate a list of trees which would be applicable in all places.

For New England and the middle Atlantic States, the sugar maple is one of the most extensively used and one of the most desirable for the purpose. The elm is very desirable, but it does not produce as dense a foliage as the maple. The Norway maple, which produces even a more dense foliage than does the sugar maple, may also be used. From Washington southward to the Carolinas the Norway maple, silver maple, sycamore, elm, red oak, willow oak, and the pin oak, which is being widely used on the streets of Washington, gives highly desirable results.

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Throughout the southern States the live oak is far ahead of any other tree for beautifying the roadsides. It is typical of that region and is one of the most beautiful trees in America. In Florida, the camphor tree might well be used. In southern Texas, the native palm would be excellent as probably would the hackberry, both native and Mexican varieties. In the Northwest, the American elm or green ash, and in California, the pepper tree and eucalyptus seem to furnish the best results in beautifying the roadsides.

Roadside trees should be planted about 50 feet apart, but alternating on each side of the road, making them really 25 feet apart. In making the selection, it would seem from the results already obtained that all trees planted on the same road between towns or intersecting roads should be of the same variety. This principle has been carried out from the early days in the City of Washington, each street having its particular variety of trees throughout its entire length or between important intersections. The results have been very satisfactory.

Another important principle of planting is that where light and air are desired, tall growing varieties should be selected and the underbrush should be trimmed out. At other places along the road conditions may require the reverse of this treatment or the elimination of all trees when open vistas are desired.

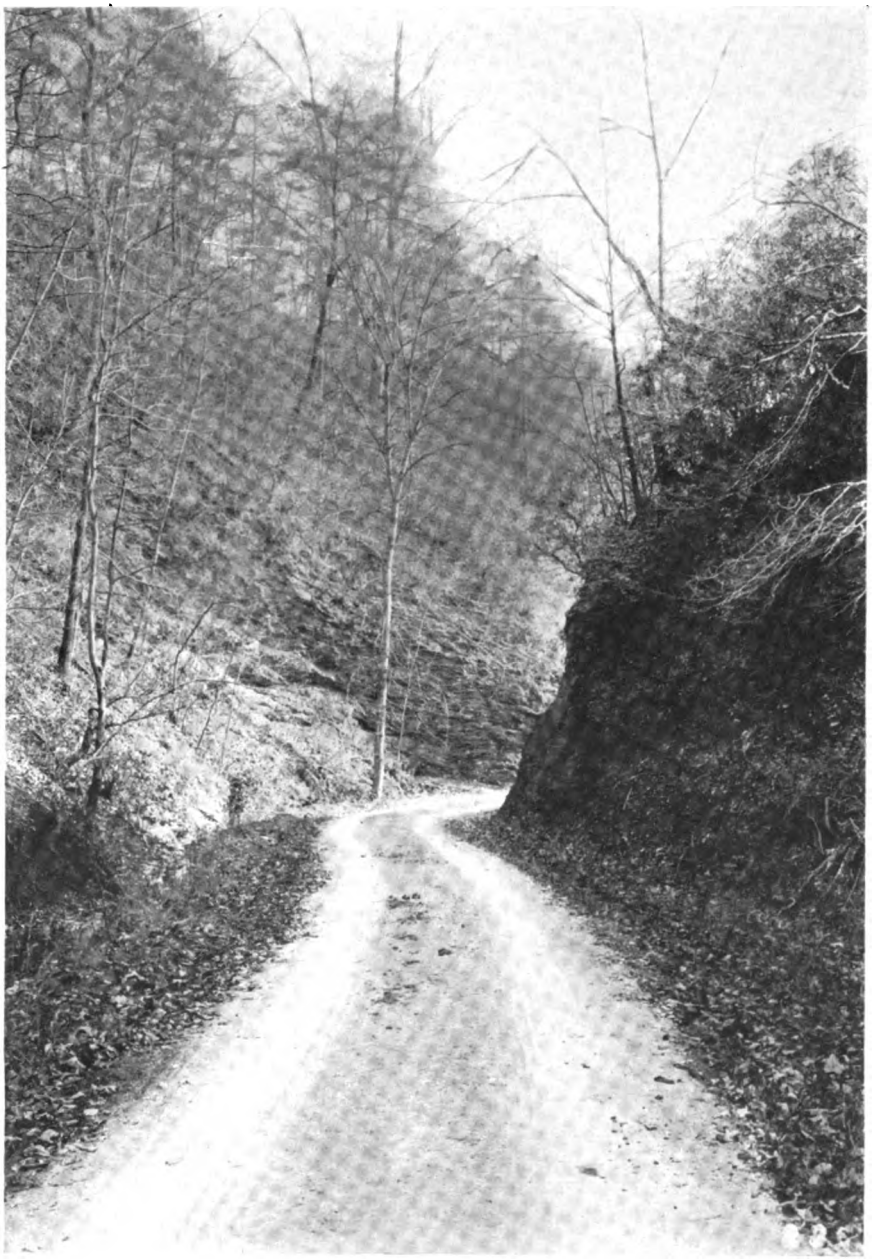
In certain foreign countries, fruit trees are planted extensively along the roadsides and a considerable revenue is derived from the sale of the fruit. The laws are strict and the trees are not molested. In India, it is reported that the Government allows abutting property owners to take the product of the fruit trees in exchange for protecting and caring for them.

Ordinarily it is better to select some long-lived shade tree than to attempt to combine fruit production with shade. However, in those sections of the United States where the land is very valuable and there is opposition to the dedication of strips along the road for shade trees, it may be found advisable to encourage the planting of fruit and nut-bearing trees, with the product becoming the property of the abutting owners.

Of the fruit-bearing trees, the apple is adapted to all sections of the United States, as far south as northern Georgia in the Appalachian region. West of the Appalachians the apple would serve as far south as the Gulf States and even extend to the Pacific Coast, with perhaps the exception of the extreme northern part of Minnesota, the Dakotas, and Montana, where the crab-apple may be used.

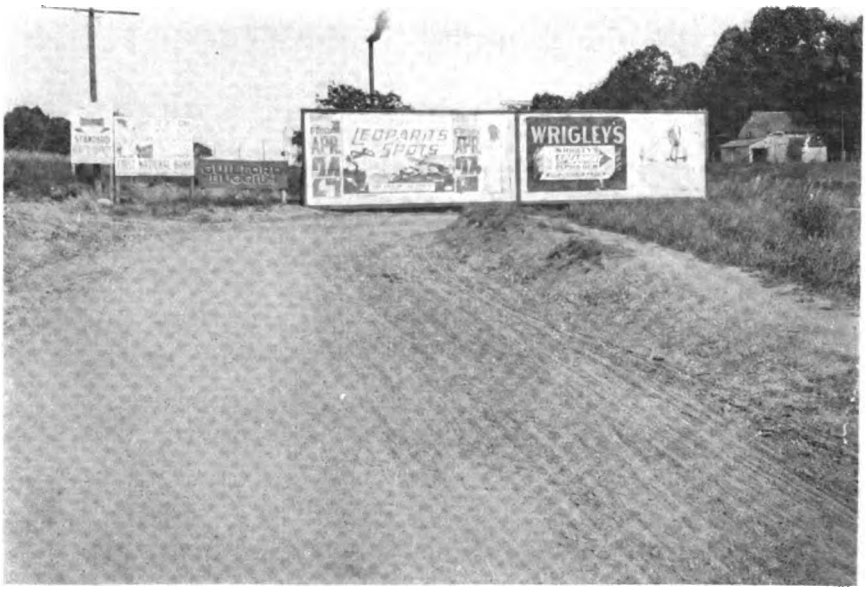
The nut-bearing trees which would be adapted to this use in eastern United States would be hickory, walnut, and butternut,

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Embankments on the inside of sharp curves like this should be removed or the road relocated. Near Clinton, Tennessee

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The worst form of roadside treatment is the billboard. It adds no beauty and provides no shade

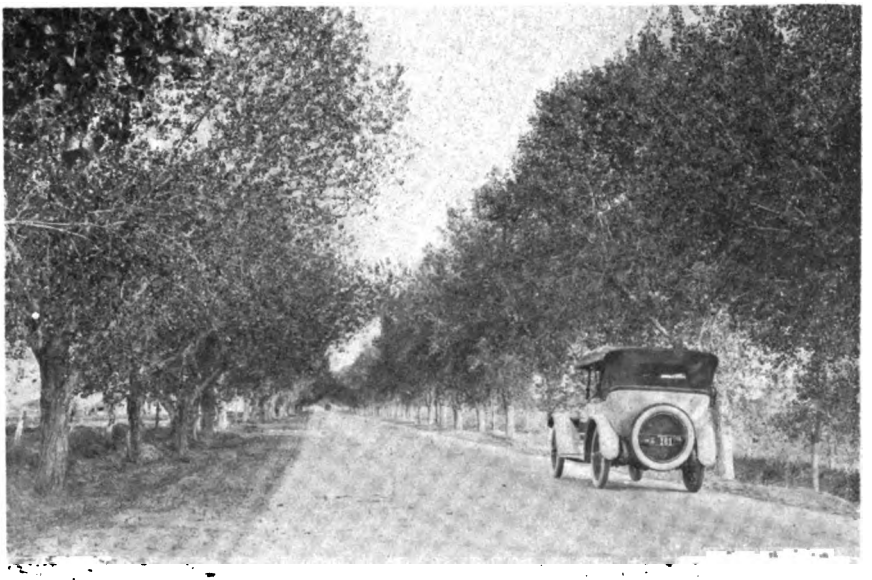


A good road needs more than a surface to make it beautiful. This road cost $43,000 per mile and not a cent was spent to make the roadside attractive or to eliminate the deep side ditches

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Parallel rows of trees, uniformly spaced, make for attractive roadsides. A State highway near Lenox, Massachusetts



A country road near El Paso, Texas. A picturesque avenue of cottonwoods

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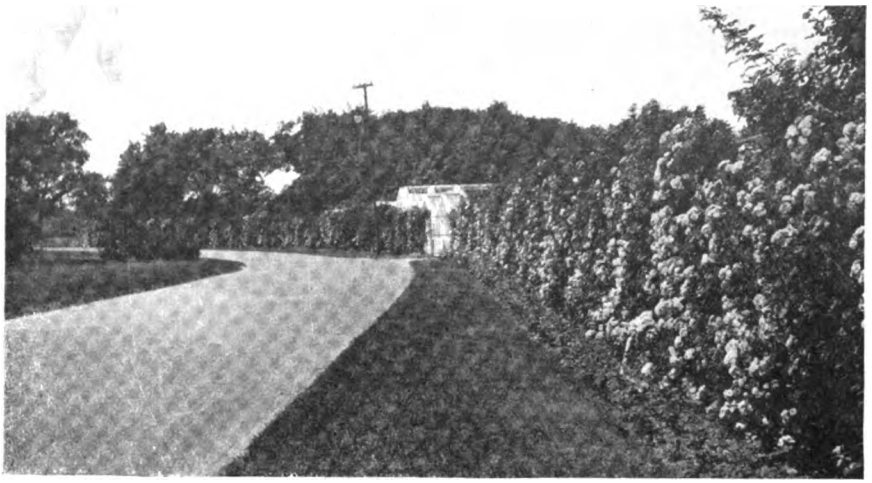


Use tall-growing trees and trim out the underbrush where light, air and open vistas are desired. On Casco Bay, Portland, Me.



In Mount Ranier National Park near Tacoma, Washington. For miles this road extends through the primeval forest of giant firs and arborvitae. A straight road may be beautiful under these circumstances

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Highway settings should be beautiful—A rose hedge. Agricultural Department Grounds, Washington, D. C.



Cut the weeds and keep the shoulders, slopes, and ditches clean. Near New Orleans, Louisiana

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On steep slopes vines, like honeysuckle prevent erosion and add beauty. Rock Creek Park, Washington, D. C.



In California the eucalyptus is effectively used as an ornamental shade tree. San Mateo County, Calif.

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for the New England States and along the Appalachian mountains as far south as Georgia. The distribution of these nut trees would take a northerly turn on the west side of the Allegheny mountains, and would perhaps not be used south of central Kentucky, and no farther west than Colorado. The hickory will not thrive in northern Iowa, northern Wisconsin, Minnesota, or in the Dakotas. The black walnut, however, will extend as far north as the southern part of Maine, over the eastern part of South Dakota, eastern Nebraska, and Kansas. On the Pacific Coast, the English walnut can be used as a substitute for the nut trees used in the eastern part of the United States, and in the South Atlantic States and the Gulf States pecans can be used as substitutes for the other nut trees mentioned.

The planting of trees should be done preferably by public authorities as a part of the improvement of the highway. Local organizations, schools, and clubs should be encouraged to participate in the work, but when they do they should have the close coöperation of public authorities and experts in order to insure proper planting. Name plates could be attached to trees, so that it would be a pride as well as a help to the community to have the trees well kept.

Flowers or shrubbery may be planted along the roadside in grouping, adding materially in making the highway pleasant and attractive. Shrubs and flowers, however, should be carefully selected and so planted that the foliage and color schemes should be massed, that open spaces should be preserved, and that straight-line planting should be avoided wherever possible.

The work done by the railroads in beautifying their station grounds and embankments is far ahead of that of the public on the highways. The railroad authorities seem to understand the need of neat maintenance work, and as a result many railroad rights of way are more attractive than our highways.

The need for constant road maintenance is well understood, but is very little practiced in this country. Europe has done much in maintaining its roads and the practice is winning favor here. A number of States have already adopted the European method; that is, the patrol system. Proper maintenance should consist not only in repairing the holes in the surface and cleaning the ditches, but should be extended to the entire rights of way.

Accumulation of rubbish renders the roadsides unsightly in appearance, and may even be a factor in bringing about unsanitary conditions. It would be well to create a strong feeling in all communities against the use of rights of ways as a dumping place for rubbish. The clean-up week which the cities are now adopting each year may well be carried into the rural districts. An

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improvement in the condition of the road always has the effect of stimulating abutting property owners to clean up and improve their places, so that work done on the roadway along these lines is doubly beneficial. The beautifying of a highway does much in making an efficient highway with the cost small compared to the uplift and benefit received.

In all roadside planning and planting the thought should be constantly borne in mind that to be really picturesque the road must also be safe for those who use it. It must be free from hazardous curves, unsafe bridges, and culverts, excessive grades, dangerous railroad crossings, and deep ditches. It should be sufficiently wide to accommodate the traffic and should be smooth and durable in order that it may be used at reasonable speeds at all seasons. It should be scientifically located with unavoidable short curves properly banked and precipices and embankments protected by suitable parapets, with all dangerous places conspicuously marked by danger signals.



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ORGANIZED HIGHWAY ROUTES OF NATIONAL AND INTERSTATE IMPORTANCE

For a number of years associations have been rapidly increasing in various parts of the country, which have for their object the promotion of the improvement of highways ranging in length from roads connecting adjacent county seats to transcontinental routes.

Many of these routes are marked more or less fully by color bands and other insignia on poles, fences, or bridges so that the traveler can easily follow them.

The main through routes in some States have been marked in this manner by the State highway departments as indicated in the chapter dealing with highway signs and markers. In other cases the markings suggested by the associations promoting the highways have been approved by State highway departments.

In a few States opposition has developed against the practice of having these roads marked by promoting associations on the ground that all signs on rights of way should be placed and maintained by public officials. There is no doubt that something should be done to expedite, simplify and standardize the present method of marking the highways. At present there are so many different classes of signs and insignia used for marking roads that travelers are apt to be confused in making trips from one place to another.

The extent to which these various associations have named and marked special routes in different parts of the country is indicated by the fact that in one section of the middle west embracing the territory lying between Dubuque and Sioux City, Iowa, Council Grove, Kansas, and Washington, Missouri, there has been laid out 80 separate and distinct trails or selected routes, many of which have separate and distinct color band markings and symbols for indicating the different highways.

A map has been prepared by the American Automobile Association indicating the principal transcontinental and main organized routes. It embraces a table of distances, color markings and indicates climatic conditions for various regions and seasons. A copy of this map can be secured from the association at a cost of $1 per copy with a discount of 50 per cent to members.

These boosting associations are on the whole doing a tremendous amount of good and their mere existence and popular support indicate that there is a real need and an urgent desire on the

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part of road users and the public generally for roads which start somewhere and go somewhere.

It was impossible to include in the Highways Green Book the names of all the various organizations which are promoting selected routes in various parts of the United States. Many of the more important ones are listed as follows, but there are doubtless others which should have been included also.

Organized Highways of National Importance

BANKHEAD HIGHWAY—B. Manley Allen, Pres. J. A. Rountree, Secy., 1021 Brown-Marx Bldg., Birmingham, Ala. Washington, D. C., to San Diego, Cal.

DIXIE HIGHWAY—M. M. Allison, Pres.; V. D. L. Robinson, Secy., Hotel Patten, Chattanooga, Tenn. Mackinaw, Mich., to Miami, Fla.

DIXIE—OVERLAND HIGHWAY—Col. Ed. Fletcher, Pres., San Diego, Cal.; Leland J. Henderson, Secy., Columbus, Ga. Savannah, Ga., to San Diego, Cal.

EVERGREEN NATIONAL HIGHWAY—F. H. Sweetland, Pres.; S. E. Brokaw, Secy., Tacoma, Wash. Victoria, B. C., to El Paso, Tex.

GEORGE WASHINGTON NATIONAL HIGHWAY—P. A. Wells, Pres.; W. B. Cheek, Secy., 640 Paxton Block, Omaha, Neb. Seattle, Wash., to Savannah, Ga.

JACKSON HIGHWAY—P. L. Atherton, Pres.; R. R. Hikes, Secy., 315 Atherton Bldg., Louisville, Ky. Chicago, Ill., to New Orleans, La.

JEFFERSON HIGHWAY—Walter Parker, Pres., New Orleans, La.; J. D. Clarkson, Gen. Mgr., St. Joseph, Mo. Winnipeg, Can., to New Orleans, La.

KING OF TRAILS—W. W. Brown, Pres.; Parsons, Kans.; Frank A. Davis, Secy., Rosedale, Kan. Winnipeg, Can., to Galveston, Tex.

LAKES TO GULF HIGHWAY—C. F. Adams, Pres.; Harry E. Graham, Secy.-Treas., Chillicothe, Mo. Duluth, Minn., to Galveston, Tex.

LINCOLN HIGHWAY—F. A. Seiberling, Pres.; A. F. Mement, Secy., Garfield Bldg., Detroit, Mich. New York to San Francisco.

MERIDIAN HIGHWAY—J. C. Nicholson, Pres., Newton, Kan.; G. A. MacNaughton, Secy., San Marcos, Tex. Winnipeg, Can., to Laredo, Tex.

MISSISSIPPI VALLEY HIGHWAY (Formerly Burlington Way)—C. B. B. Nicholson, Pres., St. Louis, Mo.; H. C. Wilhite, Secy., 2621 College Ave., Alton, Ill. Duluth, Minn., to New Orleans, La.

NATIONAL OLD TRAILS ROAD—J. M. Lowe, Pres., Railway Exchange Bldg., Kansas City, Mo.; Frank Davis, Secy., Rosedale, Kan. Washington, D. C., to Los Angeles, Cal.

OLD SPANISH TRAIL—Parmer Pillans, Pres.; H. B. Ayres, Mgr. Director, San Antonio, Tex. Jacksonville, Fla., to San Diego, Cal.

PACIFIC HIGHWAY—Samuel Hill, Pres., Maryhill, Wash.; Frank M. Fretwell, Secy., Seattle, Wash. Vancouver, B. C., to San Diego, Cal.

PERSHING WAY—C. H. Draper, Pres., Wells, Minn.; Herbert F. McDougal, Secy.-Mgr., Cedar Falls, Ia. Winnipeg, Can., to New Orleans, La.

PIKES PEAK OCEAN TO OCEAN HIGHWAY (Pershing Transport Route)—C. F. Adams, Pres., Chillicothe, Mo.; T. W. Ross, Secy., 121 E. Pikes Peak Ave., Colorado Springs, Colo. New York to San Francisco.

ROOSEVELT NATIONAL HIGHWAY (Midland Trail)—Wm. W. Armstrong, Pres., Rochester, N. Y.; J. Y. McClintock, Secy., Rochester, N. Y. Oyster Bay, N. Y., to Los Angeles, Cal.

SOUTHERN NATIONAL HIGHWAY—Dell M. Potter, Pres., Clifton, Ariz.; D. Rodney Ellis, Secy., Clifton, Ariz. Washington, D. C., to San Diego, Cal.

THEODORE ROOSEVELT INTERNATIONAL HIGHWAY—E. J. Filiatrault, Pres.; I. W. Lee, Gen. Mgr., care Duluth Commercial Club, Duluth, Minn. Portland, Me., to Portland, Ore.

YELLOWSTONE TRAIL—H. B. Wiley, Pres., Miles City, Mont.; J. A. Hillstead, Secy.-Treas., 916 Andrus Bldg., Minneapolis, Minn. Plymouth, Mass., to Seattle, Wash.

Organized Highways of Interstate Importance

ALBERT PIKE HIGHWAY—Cyrus S. Avery, Pres.; E. B. Guthrey, Secy., Tulsa, Okla. Hot Springs, Ark., to Colorado Springs, Col.

ARROWHEAD TRAIL—M. P. Chubb, Pres., Redlands, Cal.; F. V. Owen, Secy., 858 Figueroa St., Los Angeles, Cal. Los Angeles, Cal., to Salt Lake City, Utah.

BIG FOUR TRAIL—I. A. Lumpkin, Pres., Mattoon, Ill.; Geo. W. Bailey,

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Secy., Brookfield, Mo. Terre Haute, Ind., to St. Louis, Mo.

BOONE WAY—Jim Maret, Pres., Mount Vernon, Ky., W. H. Fish, Secy., Mount Vernon, Ky. Lexington, N. C., to Louisville, Ky.

CHICAGO, BLACK HILLS AND YELLOWSTONE PARK HIGHWAY (Black and Yellow Trail)—T. B. Roberts, Sr., Pres.; O. M. Phelps, Secy., Huron, S. D. Chicago, Ill., to Yellowstone Park, Wyo.

CORN BELT ROUTE—A. B. Hurd, Pres.; Geo. R. Curtiss, Secy., El Paso, Ill. Effner, Ind., to Burlington, Iowa.

CHICAGO, KANSAS CITY AND GULF HIGHWAY—Robt. N. Carson, Pres., Iowa City, Iowa; Harry W. Graham, Secy., Chillicothe, Mo. Chicago, Ill., to Galveston, Texas.

CUSTER BATTLEFIELD HIGHWAY—George J. Weideman, Pres., Lewistown, Mont.; W. D. Fisher, Secy., Sheridan, Wyo. Omaha, Neb., to Glacier National Park, Mon.

DALLAS - CANADIAN - DENVER HIGHWAY—D. J. Young, Pres.; W. A. Palmer, Secy., Canadian, Texas.

DENVER - YELLOWSTONE HIGHWAY—Chas. F. Patterson, Secy., Lander, Wyo.

FT. SMITH - PAULS VALLEY - WICHITA FALLS HIGHWAY—J. R. McChesney, Pres., Pauls Valley, Okla.; Thos. F. Hodge, Gen. Secy., Devol, Okla.

FOUR STATES BRANCH - BANK - HEAD HIGHWAY—C. O. Johnson, Pres., Durant, Okla. Hot Springs, Ark., to Roswell, N. M.

GEYSER-TO-GLACIER HIGHWAY—M. Max Goodsill, Secy., Helena, Mont. Yellowstone to Glacier Parks.

GRANT HIGHWAY—Malcolm MacKinnon, Secy., Rockford, Ill. Chicago, Ill., to Portland, Ore.

KANSAS, OKLAHOMA, TEXAS AND GULF HIGHWAY—J. R. McChesney, Pres., Pauls Valley, Okla.; Thos. F. Hodge, Secy-Treas., Devol, Okla. Florence, Kan., to Dallas, Texas.

LOGAN-LEE HIGHWAY—Geo. H. Goodall, Pres.; Kirby Smith, Secy., Mt. Vernon, Ill. Rock Island, Ill., to Paducah, Ky.

LEE HIGHWAY—D. D. Hull, Jr., Pres.; Jno. Wood, Secy-Treas., Roanoke, Va. Gettysburg, Pa., to New Orleans, La.

ROBERT E. LEE TRANSCONTINENTAL HIGHWAY—F. A. Schaeffer, Pres., Houston, Texas; H. H. Peden, Secy., Houston, Texas. New Orleans, La., to El Paso, Texas.

LEWIS AND CLARK HIGHWAY—R. C. Beach, Pres.; Jesse Adam, Secy., Lewiston, Idaho. Lewiston, Ida., to Missoula, Mon.

MARK TWAIN ROUTE—Henry G. Briggs, Pres., Quincy, Ill.; Geo. W. Bailey, Secy., Brookfield, Mo. Chicago, Ill., to Kansas City, Mo.

NATIONAL PARK-TO-PARK HIGHWAY—Gus Holm's, Pres.; L. L. Newton, Secy., Cody, Wyo. Circuit of National Parks.

NATIONAL PARKS HIGHWAY—W. G. Edens, Pres., Chicago, Ill.; Frank W. Guilbert, Secy., Spokane, Wash. New York, N. Y., to Seattle, Wash.

OZARK TRAIL—W. H. Harvey, Pres.; M. Leake, Secy., Monte Ne, Ark. St. Louis, Mo., to Las Vegas, N. M.

OREGON TRAIL—Sponsored by Daughters of American Revolution. Cheyenne to Portland.

OMAHA AND ST. LOUIS HIGHWAY—C. F. Adams, Pres., Chillicothe, Mo.; U. S. House, Secy., Sumner, Mo.

OMAHA, LINCOLN AND DENVER HIGHWAY—C. F. Roper, Pres., Lincoln, Neb.; O. M. Parke, Secy., Lincoln, Neb.

PANHANDLE PACIFIC HIGHWAY—J. L. Stublefield, Secy., Estancia, N. M. Amarillo, Texas, to Albuquerque, N. M.

PERSHING HISTORIC HIGHWAY—Bert A. George, Pres.; Walter S. Whitten, Secy., Lincoln, Neb.

RED BALL ROUTE—Robt. N. Carson, Pres., Iowa City, Iowa. St. Paul, Minn., to St. Louis, Mo.

RIVER - TO - RIVER ROAD—L. V. Russell, Pres.; E. H. Spaulding, Secy-Treas., Grinnell, Iowa. Davenport, Iowa, to Omaha, Neb.

SOUTHWEST TRAIL—C. M. McFartidge, Pres.; A. G. Hawk, Secy., Moravia, Iowa. Chicago, Ill., to Kansas City, Mo.

TEXAS-NEW MEXICO-MOUNTAIN HIGHWAY—J. W. Corn, Tucumcari, N. M. Amarillo, Texas, to Las Vegas, N. M.

TWIN CITY, BLACK HILLS AND YELLOWSTONE HIGHWAY—J. W. Daugherty, Pres.; O. C. Turner, Secy., Watertown, S. D.

UTAH - IDAHO - YELLOWSTONE HIGHWAY—Mark Austin, Pres., Rexburg, Idaho; M. B. Yeaman, Secy.-Treas., Idaho Falls, Idaho. Salt Lake City to Yellowstone National Park.

WHITE MOUNTAINS BRANCH - BANKHEAD HIGHWAY—Dr. S. M. Johnson, Secy., Ruidoso, N. M. Sweetwater, Texas, to El Paso, Texas, via Roswell, N. M.

YELLOWSTONE HIGHWAY—L. L. Newton, Pres.; Gus Holm's, Secy., Cody, Wyo. Denver, Colo., to Yellowstone National Park.

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NATIONAL AND INTERSTATE ROADS AND AFFILIATED ORGANIZATIONS

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS—Pres. Paul D. Sargent, Augusta, Me.; Joseph Hyde Pratt, Secy., Chapel Hill, N. C.

AMERICAN ROAD BUILDERS ASSOCIATION—Geo. P. Coleman, Pres., Richmond, Va.; E. L. Powers, Secy., 150 Nassau St., New York.

ASSOCIATED HIGHWAYS OF AMERICA—C. F. Adams, Pres., Chillicothe, Mo.; Frank A. Davis, Secy., 1020 Oak St., Kansas City, Mo.

FEDERAL HIGHWAY COUNCIL—S. M. Williams, Pres.; H. G. Shirley, Secy., 409 McKim Bldg., Washington, D. C.

NATIONAL GRANGE—Prof. Thomas C. Atkeson, Chairman, National Legislative Committee and National Representative; A. M. Loomis, Assistant Representative, 303 7th St. N. W., Washington, D. C.

NATIONAL HIGHWAY TRAFFIC ASSOCIATION—Arthur H. Blanchard, Pres., University of Michigan, Ann Arbor, Mich.; Elmer Thompson, Secy., 237 W. 54th St., New York City, N. Y.

NATIONAL HIGHWAYS ASSOCIATION—Chas. Henry Davis, Pres., "Elmwood," Cambridge, Mass.

NATIONAL PARKS TOURING ASSOCIATION—Gus Holm's, Pres.; L. L. Newton, Secy-Treas., Cody, Wyo.

PACIFIC NORTHWEST TOURIST ASSOCIATION—Hon. A. E. Todd, Pres., Victoria, B. C.; Herbert Cuthbert, Secy., L. C. Smith Bldg., Seattle, Wash.

PUBLIC LAND STATES HIGHWAYS ASSOCIATION—Louis E. Bean, Pres., Portland, Ore.; Harry R. Hawley, Secy., 1100 Vermont Ave., Washington, D. C.

SOUTHERN APPALACHIAN GOOD ROADS ASSOCIATION—A. D. Williams, Pres., Morgantown, W. Va.

SOUHTERN COMMERCIAL CONGRESS—Hon. Duncan U. Fletcher, Pres.; Clarence J. Owens, Managing Director, Southern Bldg., Washington, D. C.

TRI-STATE GOOD ROADS ASSOCIATION—J. A. Westerlund, Pres., Medford, Ore.; George E. Boos, Secy., Medford, Ore.

UNITED STATES GOOD ROADS ASSOCIATION—Hon. J. H. Bankhead, Pres.; J. A. Rountree, Secy., Brown-Marx Bldg., Birmingham, Ala.

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STATE ROADS ASSOCIATIONS

ALABAMA GOOD ROADS ASSOCIATION—Hon. John Craft, Pres.; J. A. Rountree, 1021 Brown-Marx Bldg., Birmingham, Ala.

ARIZONA GOOD ROADS ASSOCIATION—Dwight B. Heard, Pres.; Harry Welch, Secy., Phoenix, Ariz.

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SOUTHEASTERN IDAHO GOOD ROADS ASSOCIATION—Theodore Turner, Pres., Pocatello, Idaho.

ILLINOIS ASSOCIATION FOR HIGHWAY IMPROVEMENT—W. G. Edens, Pres., 125 W. Munroe St., Chicago, Ill.

KANSAS GOOD ROADS ASSOCIATION—A. Q. Miller, Pres., Belleville, Kansas; H. A. Russell, Secy., Fort Scott, Kans.

MASSACHUSETTS HIGHWAY ASSOCIATION—Wm. J. Gannon, Pres., Fitchburg, Mass.; John M. McCarthy, Secy., 15 Ashburton Place, Boston, Mass.

MICHIGAN PIKES ASSOCIATION—G. Edward Bleil, Pres., 482 Lafayette Blvd. W., Detroit, Mich.; Willard K. Buch, Secy., 1220 Book Bldg., Detroit, Mich.

MICHIGAN STATE GOOD ROADS ASSOCIATION—P. T. Colgrove, Pres., Hastings, Mich.; A. A. Anderson, Secy., Hastings City Bank, Hastings, Mich.

MONTANA HIGHWAY IMPROVEMENT ASSOCIATION—Nelson B. Story, Jr., Pres.; J. A. Harader, Secy., Bozeman, Mont.

MONTANA GOOD ROADS CONGRESS—H. W. Brown, Pres.; P. N. Bernard, Secy., Kalispell, Mont.

NEBRASKA GOOD ROADS ASSOCIATION—George Wolz, Pres., Fremont, Nebr.; C. H. Roper, Secy., Lincoln, Nebr.

NEVADA HIGHWAY ASSOCIATION—George A. Campbell, Pres., Carman H. Jewett, Secy., Reno, Nev.

NEW HAMPSHIRE GOOD ROADS ASSOCIATION—Frederic E. Everett, Pres.; W. B. Howe, Secy., Concord, N. H.

NEW YORK ROAD BUILDERS' ASSOCIATION—John H. Gordon, Pres.; M. F. Duggan, Secy., Albany, N. Y.

NORTH CAROLINA GOOD ROADS ASSOCIATION—W. A. McGirt, Pres., Wilmington, N. C.; Dr. Joseph Hyde Pratt, Secy., Chapel Hill, N. C.

WILMINGTON-CHARLOTTE-ASHEVILLE HIGHWAY ASSOCIATION—T. L. Kirkpatrick, Pres.; W. C. Wilkinson, Secy., Charlotte, N. C.

OHIO GOOD ROADS FEDERATION—Royal R. Scott, Sidney, Ohio; W. A. Alsdorf, Secy., Hartman Bldg., Columbus, Ohio.

VIRGINIA GOOD ROADS ASSOCIATION—C. C. Vaughan, Pres., Franklin, Va.; D. B. Ryland, Secy.-Treas., Lynchburg, Va.

WASHINGTON STATE GOOD ROADS ASSOCIATION—N. B. Coffman, Pres., Chehalis, Wash.

GOOD ROADS ASSOCIATION OF WISCONSIN—Elmer S. Hall, Pres.; Francis Cannon, Secy., Cantwell Bldg., Madison, Wisc.

WISCONSIN HIGHWAY COMMISSIONERS ASSOCIATION—W. E. Dillon, Secy., Butternut, Wisc.

WYOMING GOOD ROADS ASSOCIATION—L. L. Newton, Pres., Cody, Wyo.; A. L. Emiry, Secy., Plains Hotel, Cheyenne, Wyo.

Foreign Roads Organizations

INTERNATIONAL ASSOCIATION OF ROAD CONGRESSES—W. Rees Jeffreys, Secy., 35 Cromwell Road, South Kensington, London, S. W.

CANADIAN GOOD ROADS ASSOCIATION—S. L. Squire, Pres., George A. McNamee, Secy.-Treas., 909 New Birks Bldg., Montreal, Quebec.

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HIGHWAY MILEAGE AND EXPENDITURES IN THE UNITED STATES, 1918 [1]

Based on complete reports from 44 of the States, cash expenditures on the rural roads and bridges of the United States for the calendar year 1918 amounted to $286,098,193. To this should be added the value of statute and convict labor, which can not be fixed with any great degree of accuracy but probably amounted to not less than $14,000,000, thus making the grand total expenditures for the year $300,000,000. This total is made up of the actual expenditures for such items as labor, materials, supervision and administration directly connected with the construction, improvement, and upkeep of our public roads and bridges outside the limits of incorporated towns and cities, and does not include any item for sinking-fund payments or redemption and interest on road and bridge bonds.

The year 1918 offered an unprecedented condition in practically all lines of highway work. There was not only a tremendous increase and expansion in the amount of heavy truck traffic on our public roads and an unprecedented shortage in regard to road materials, labor, and ready funds, but also a decided increase in maintenance work, which was, however, partially offset by a decrease in the amount of new construction.

The most striking single development through the year was the tremendous increase in motor-truck traffic. Five years ago heavy motor trucks were few in number and limited practically entirely to the paved streets of our larger cities. These vehicles now comprise probably 4 to 5 per cent of the grand total of all our motor vehicles and are to be found wherever traffic conditions permit of their profitable use. But very few of our present roads were designed to carry any large volume of this class of traffic. Consequently, the cost of adequate maintenance was increased greatly during the year. In many places the damage due to the incessant pounding of these fast and heavy vehicles was so great as to require complete reconstruction.

The undertaking of new construction work was of necessity deferred to a large extent during 1918. However, in spite of a sadly reduced and broken organization due to the demands of the war, there continued throughout the year among the several State highway departments a decided forward-looking movement to the

[1] Extract from Public Roads, issued in July, 1919, by the Bureau of Public Roads, United States Department of Agriculture. Prepared by Andrew P. Anderson, highway engineer.

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time when hostilities should be ended. This movement consisted largely in formulating definite plans for the renewal of all lines of activities on an increased scale at the earliest possible moment. Thus, Illinois and Pennsylvania each voted bond issues providing for the construction of a comprehensive system of State roads, with the understanding, however, that none of the money should be expended until after the war had closed.

The full effect of this movement, however, did not become apparent until the early part of 1919, when State and county governments began to make provision for road funds to an extent entirely unknown before.

The Federal Government also made provision for a considerable increase in the amount of funds available under the Federal aid road act of July 11, 1916, for the improvement of rural post roads and forest roads. The Post Office appropriation act, approved February 28, 1919, carried an amendment to the above act which provided for an additional appropriation of $209,000,000 for Federal coöperation in the improvement of rural post roads and forest roads, to be available during the year 1919, 1920, and 1921.

Definite data are not available as to the amount of county, town, district, and other forms of local road bonds which have been voted during the period covered by this investigation. There is, however, abundant evidence that this total far exceeds that already voted by the several States. Many of the State governments, as well as local communities, have also made provisions for considerable increase in their regular road and bridge revenues or have discovered new sources of such revenues. A large number of the States have materially increased the direct road taxes as well as the registration fees of motor vehicles. Three States—Colorado, New Mexico, and Oregon—have also placed a tax on the sale of gasoline, the income from which is to be used for road purposes.

In a few of our States the question of limiting the term of road and bridge bonds to the probable life of the improvement for which they are issued has as yet received but scant attention. The practice of issuing 30- or 40- or even 50-year bonds to pay for an improvement which can not possibly last more than one-half and probably not more than one-third or one-fourth of this period is neither good finance nor good common sense. In no case should the term of these bonds exceed the most probable life or productive period of the improvement.

Another practice which has served to cover up this evil is that of taking up road bonds on or before their maturity by means of so-called funding or refunding bonds, which almost

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TABLE I.—*Expenditures During* 1918, *by or Under Supervision of State Highway Departments*

STATE	FUNDS				Local Road and Bridge Expenditures, 1918, Not Under State Highway Department (Approximate)
	Federal	State	Local	Total	
Alabama	$ 133,380.90	$ 103,285.32	$ 134,547.20	$ 371,213.42	$ 2,000,000
Arizona[1]	31,947.35	975,801.95	10,000.00	1,017,749.30	1,000,000
Arkansas	41,778.52	221,831.24	.....	263,609.76	1,700,000
California	26,399.00	6,941,192.00	29,179.00	6,996,770.00	14,649,868
Colorado	250,000.00	800,000.00	400,000.00	1,450,000.00	1,850,000
Connecticut	5,301.15	3,172,706.35	396,600.08	3,574,607.58	1,444,212
Delaware	5,268.40	429,734.43	208,373.86	643,376.69	300,000
Florida	9,972.55	179,807.22	328,722.38	518,502.15	5,245,703
Georgia	21,158.00	15,000.00	55,898.00	92,056.00	5,700,000
Idaho	48,936.00	491,342.00	479,642.00	1,019,920.00	2,500,000
Illinois	.....	860,910.99	1,216,312.87	2,077,223.86	8,106,129
Indiana	.....	.....	.....	.....	13,000,000
Iowa	75,853.12	113,488.49	14,360,280.61	14,549,622.22	.....
Kansas	8,083.90	25,000.00	1,922,766.10	1,955,850.00	3,061,267
Kentucky	.....	1,000,000.00	580,000.00	1,580,000.00	1,800,000
Louisiana[1]	.....	182,295.00	358,681.00	540,976.00	3,000,000
Maine	81,611.96	1,570,493.75	707,309.05	2,359,414.76	1,500,000
Maryland	4,767.73	2,681,141.89	64,225.50	2,750,135.12	3,000,000
Massachusetts	33,440.00	3,522,493.89	568,369.00	4,124,302.89	5,000,000
Michigan[1]	.....	1,704,359.00	3,968,794.00	5,673,152.00	5,000,000
Minnesota	224,357.76	1,870,336.01	3,300,216.08	5,394,909.85	5,172,801
Mississippi	.....	10,000.00	.....	10,000.00	750,000
Missouri	.....	704,400.00	450,000.00	1,154,400.00	6,000,000
Montana	.....	133,547.77	.....	133,547.77	3,791,402
Nebraska	41,866.21	201,202.44	112,759.72	355,828.37	3,500,000
Nevada	.....	75,327.59	.....	75,327.59	399,442
New Hampshire	20,530.23	651,593.70	332,561.21	1,004,685.14	1,000,000
New Jersey[2]	.....	1,848,932.41	1,860,000.00	3,708,932.41	3,000,000
New Mexico	.....	527,071.57	487,120.53	1,014,192.10	300,000
New York[1]	.....	9,432,679.00	2,282,452.00	11,715,130.65	9,000,000
North Carolinal	.....	20,000.00	.....	20,000.00	4,000,000
North Dakota	71,000.00	83,000.00	54,000.00	208,000.00	3,000,000
Ohio	169,075.76	4,670,270.22	3,660,487.75	8,499,833.73	6,000,000
Oklahoma	.....	1,046,892.75	1,577,610.01	2,624,502.76	507,029
Oregon	.....	2,120,551.24	709,724.79	2,830,276.03	4,000,000
Pennsylvania	137,437.17	[3]8,041,833.86	574,605.09	8,753,876.12	6,000,000
Rhode Island	34,997.13	745,673.91	.....	780,671.04	355,000
South Carolina	50,754.92	49,238.61	40,911.87	140,905.40	1,535,334
South Dakota	.....	30,473.35	1,236.18	31,709.53	3,000,000
Tennessee	.....	403,000.00	75,000.00	478,000.00	2,500,000
Texas	95,510.65	295,567.38	1,934,648.72	2,325,726.75	9,000,000
Utah	.....	1,546,842.53	60,417.72	1,607,260.25	1,163,231
Vermont	5,000.00	778,075.00	223,000.00	1,006,075.00	600,000
Virginia	24,516.57	861,030.69	1,322,804.80	2,208,352.06	1,500,000
Washington	128,439.10	2,922,436.11	205,430.45	3,256,305.66	4,000,000
West Virginia	42,782.17	171,581.32	342,090.76	556,454.25	4,500,000
Wisconsin	225,319.00	2,051,455.00	3,307,401.00	5,584,175.00	3,700,000
Wyoming	59,053.61	67,582.26	121,071.74	247,707.61	681,507
Total and average	$2,108,538.86	$66,351,478.24	$48,825,251.07	$117,285,267.82	$ 168,812,925

[1] Data for 1917. Data for 1918 not available. [2] Approximate. [3] Exclusive of $143,765 State funds distributed to townships.

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TABLE II.—*Distribution of expenditures made by or under supervision of State Highway Departments*

STATES	CONTRUCTION		Maintenance, Roads and Bridges	Engineering	Administration	Equipment and Miscellaneous	State Funds Available, 1919 (Approximate)
	Roads	Bridges					
Alabama	$ 314,163	$ 27,230		$ 18,262	$ 11,559		$ 350,878
Arizona	608,677	191,093	$ 82,255	68,285	44,552	$ 22,888	1,850,000
Arkansas	229,997	16,304		9,808	7,500		700,000
California	5,237,420	[1]	894,921	324,720	234,392	305,317	6,500,000
Colorado	410,000	120,000	800,000	[2]	100,000	20,000	1,000,000
Connecticut	1,640,707	295,927	1,256,565	165,023	23,285	193,101	4,000,000
Delaware	606,606	8,050	2,153	24,632	1,936		1,500,000
Florida	389,111	3,664	80,092	33,321	8,196	4,118	732,430
Georgia	72,368	800		18,888	[2]		15,000
Idaho	651,033	133,796	115,540	93,423	22,384	3,744	1,000,000
Illinois	1,787,357	59,669	65,557	129,030	30,911	4,700	10,000,000
Indiana							4,000,000
Iowa	2,931,526	4,972,168	4,158,254	453,870	[2]	2,033,804	4,000,000
Kansas	131,250	1,600,600		225,000	[2]		25,000
Kentucky	1,100,000	300,000	60,000	65,000	25,000	30,000	1,500,000
Louisiana	430,708	35,984	9,841	42,107	20,060	2,276	200,000
Maine	1,333,776	263,500	613,805	60,129	42,941	45,265	2,010,000
Maryland	1,064,674	105,875	1,368,860	68,601	24,425	117,700	3,800,000
Massachusetts	1,389,153	3,150	2,365,794	188,688	60,535	116,984	4,597,500
Michigan	5,125,224	187,751	247,178	62,000	43,000	8,000	2,000,000
Minnesota	3,146,867	942,119	1,000,867	[3]	305,057		2,529,049
Mississippi				2,500	7,500		10,000
Missouri	900,000		181,000	17,600	38,800	17,000	3,000,000
Montana	36,987	27,767		32,095	6,100	30,600	200,000
Nebraska	61,103	193,448	32,072	13,396	50,483	5,327	3,708,000
Nevada			16,467	21,581	20,638	16,642	650,248
New Hampshire	334,985		593,549	26,484	31,904	17,763	900,000
New Jersey	606,587		2,800,922	87,321	114,696	99,407	5,500,000
New Mexico	487,261	96,912	249,284	39,587	6,085	135,063	1,205,000
New York	5,635,027		4,537,709	1,108,622	273,874	159,899	14,000,000
North Carolina				[3]	20,000		300,000
North Dakota	115,000	28,000	600	29,500	34,900		3,000,000
Ohio	6,272,840	[1]	1,791,244	200,926	133,584	101,239	4,000,000
Oklahoma	998,865	527,422	670,726	168,200	17,512	241,776	1,212,000
Oregon	1,948,936	617,388		162,384	63,491	38,076	5,000,000
Pennsylvania	1,694,011	279,359	5,473,193	227,335	260,267	[4]819,711	16,000,000
Rhode Island		109,696	600,720	44,634	10,000	15,622	800,000
South Carolina	113,921	2,746		[5]14,022	8,961	1,255	275,000
South Dakota	6,831			14,007	10,871		2,000,000
Tennessee	38,000		400,000	20,000	20,000		1,800,000
Texas	901,391		1,306,336	85,000	33,000		1,900,000
Utah	845,929	85,961	231,341	108,892	72,594	262,543	3,000,000
Vermont	494,000	55,000	445,000	2,075	10,000		800,000
Virginia	1,251,561	138,945	695,537	68,793	51,435	2,082	1,660,000
Washington	2,520,574	152,576	559,768	[3]	23,388		5,000,000
West Virginia	444,659	72,838	17,758	11,800	9,400		1,290,000
Wisconsin	3,175,126	993,966	1,250,000	[3]	165,083		2,500,000
Wyoming	163,198	17,773		39,146	11,736	15,855	2,000,000
Total and average	$57,647,409	$12,667,477	$34,974,908	$ 4,596,687	$ 2,512,035	$ 4,887,757	$133,670,105

[1] Included under roads. [2] Included under administration. [3] Included under engineering.
[4] Included $384,975 for purchase of toll roads. [5] Included survey of about 138 miles of proposed construction.

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invariably have a long term. In this way not only is the term of the debt continued for a very much longer period, but it is placed in such form as to cover or conceal its relation to the road improvement. Consequently, the full extent of the bond burden resulting from our past road and bridge expenditures is impossible of exact determination. Estimates based on the best available data would seem to show that there are at least $400,000,000 outstanding which are actually designated as road and bridge bonds or warrants. These are at present maturing at a rate in excess of $20,000,000 per year and a like or greater amount is required annually for interest payments. For a number of years past new road and bridge bonds have been issued at the rate of about $40,000,000 per annum, and while there has been a marked decrease during 1917 and 1918, there is now abundant promise of a very decided increase.

The expenditures on our city, town, and village streets are not included in these compilations, as no complete records are available as to their amount. However, it is estimated that the expenditures on account of our streets amount in round numbers to $300,000,000 annually, or approximately the same as that expended on our rural roads and bridges. Many of our city streets are in reality only extension or connecting links in our main highway systems. With these present tremendous development of motor-truck and automobile traffic these streets become an important and vital factor in the efficient operation and functioning of our general highway system, and especially to any general plan of motor hauling involving the delivery of country produce. It is, therefore, hoped that more definite data in regard to the extent, cost, and conditions of our city streets may soon be available.

The abnormal conditions during 1917 and 1918 had a very decided effect on road and bridge work. From 1904 to 1916 the average annual increase in the total rural road and bridge expenditures was about 10 per cent over and above those of each previous year. During the years 1917 and 1918, however, this increase was reduced to about 2½ per cent. The part which the several States pay in comparison with that of the local subdivisions, on the contrary, has continued to increase at a uniformly rapid rate. In 1904 eleven State highway departments expended a total of $2,550,000 for road and bridge work, and in 1914, thirty-one State highway departments expended $4,221,000. In 1917 every State in the Union participated and the total expenditure of State funds amounted to $47,291,000. In 1918 this had reached a total of $66,351,000.

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TABLE III.—*Road Mileage*

STATE	WORK DONE IN 1918 UNDER STATE SUPERVISION			MILES OF RURAL PUBLIC ROADS		
	State and State-Aid Roads Built, 1918	Roads Maintained with State Aid, 1918	Number of Bridges Built by State Aid 1918	Total all Surfaced Roads in State (Approximate)	Total all Public Rural Roads in State	Percentage of Surfaced Roads in State
Alabama	[1]109	.....	2	6,125	55,446	11.0
Arizona	52	436	10	475	12,075	3.9
Arkansas	[2]	.....	[2]	2,000	50,743	4.0
California	[3]260	2,521	11	13,000	61,039	21.2
Colorado	[4]100	7,000	15	2,550	39,780	6.4
Connecticut	[5]55	1,481	13	3,200	14,061	22.6
Delaware	10	20	1	310	3,674	8.5
Florida	[6]77	362	1	3,900	17,995	21.6
Georgia	17	.....	2	13,200	80,669	16.4
Idaho	[7]90	490	12	850	24,396	3.5
Illinois	[8]232	736	80	12,800	95,647	13.4
Indiana	.....	.....	.....	31,000	73,347	42.5
Iowa	[9]2,969	104,082	[10]10,237	1,500	104,074	1.4
Kansas	19	.....	[2]	1,550	111,052	1.4
Kentucky	[11]214	65	150	13,900	57,916	24.0
Louisiana	[2]	[2]	[2]	2,700	24,563	11.0
Maine	[12]160	4,235	19	3,525	23,537	14.9
Maryland	192	1,433	5	3,100	16,459	18.8
Massachusetts	72	[13]2,000	1	9,100	18,681	48.8
Michigan	150	.....	.....	10,600	74,190	14.3
Minnesota	[14]1,643	12,089	[15]640	7,000	93,517	7.5
Mississippi	.....	.....	.....	2,700	45,779	5.9
Missouri	[16]300	[16]11,400	.....	7,550	96,041	7.8
Montana	[17]83	.....	9	900	39,204	2.3
Nebraska	[18]41	.....	6	1,450	80,272	1.8
Nevada	.....	260	.....	340	12,182	2.8
New Hampshire	[19]52	1,479	.....	2,000	14,020	14.5
New Jersey	16	2,450	.....	6,050	14,817	41.0
New Mexico	[20]1,268	6,035	163	620	[21]43,091	1.4
New York	[2]	[2]	[2]	18,400	79,398	23.2
North Carolina	[2]	[2]	[2]	6,850	50,758	13.5
North Dakota	[22]110	65	.....	1,160	68,796	1.8
Ohio	[23]342	2,485	7	31,800	86,354	36.8
Oklahoma	[24]927	2,592	614	700	107,916	.7
Oregon	[25]213	.....	60	5,000	36,819	14.1
Pennsylvania	44	8,495	167	10,600	91,556	11.6
Rhode Island	[26]15	325	12	750	2,170	34.5
South Carolina	11	.....	1	3,800	42,226	9.0
South Dakota	[2]	.....	.....	800	96,306	.8
Tennessee	12	3,800	.....	8,880	46,050	19.2
Texas	200	13,000	.....	12,300	128,960	9.6
Utah	109	367	.....	1,650	8,810	18.6
Vermont	110	4,300	.....	2,300	14,249	16.3
Virginia	[27]358	3,054	39	6,150	53,388	11.7
Washington	[28]275	1,411	6	6,300	42,428	14.9
West Virginia	[29]135	88	12	1,600	32,024	5.0
Wisconsin	[30]735	5,000	670	15,500	77,280	20.1
Wyoming	[31]167	.....	8	600	14,797	4.1
Total and average.	11,944	203,556	12,973	299,135	2,478,552	12.0

[1] Includes 12 miles of earth roads.
[2] Data not available.
[3] Includes 87 miles of earth roads.
[4] Includes 64 miles of earth roads.
[5] Includes 34 miles of reconstruction.
[6] Includes 5 miles of earth roads.
[7] Includes 75 miles of earth roads.
[8] Includes 64 miles of earth roads.
[9] Includes 2,549 miles of earth roads.
[10] Includes culverts.
[11] Includes 45 miles of earth roads.
[12] Includes 5 miles of earth roads.
[13] Includes about 792 miles of town roads.
[14] Includes 1,207 miles of earth roads.
[15] Includes 245 miles of earth roads; excludes 200 miles partially com-
[16] Dragging only.
[17] Includes 32 miles of earth roads.
[18] Includes 36 miles of earth roads.
[19] Includes 9 miles of reconstruction.
[20] Includes 1,063 miles of earth roads.
[21] As reported by State highway engineer May, 1919.
[22] Includes 100 miles of earth road.
[23] Includes 22 miles of earth roads.
[24] Includes 716 miles of earth roads.
[25] Includes 100 miles of earth roads.
[26] All reconstruction.
[27] Includes 44 miles of earth roads and 52 miles of reconstruction.
[28] Includes 140 miles of earth roads.
[29] Includes 111 miles of earth roads.
[30] Includes 373 miles of earth roads.
[31] Includes 144 miles of earth roads.

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TABLE IV.—*Total Cash Expenditure From all Sources (Approximate)*

STATE	1904	1914	1916	1917	1918
Alabama	$ 378,040	$ 3,949,019	$ 4,186,384	$ 2,669,022	$ 2,371,213
Arizona	67,591	982,721	1,988,221	1,569,422	2,017,749
Arkansas	681,934	1,522,696	3,443,887	3,335,262	1,963,610
California	2,157,396	19,171,985	20,392,434	18,245,200	21,646,638
Colorado	635,395	1,937,546	2,313,208	2,570,000	3,300,000
Connecticut	1,195,125	3,640,963	3,200,948	4,004,225	5,018,820
Delaware	90,803	511,628	512,000	321,600	943,377
Florida	437,184	2,280,255	4,010,484	6,384,797	5,764,205
Georgia	894,936	3,688,172	3,750,000	4,318,350	5,792,056
Idaho	201,648	1,371,469	1,948,118	2,092,723	3,519,920
Illinois	3,844,424	8,734,713	10,356,669	10,083,728	10,183,353
Indiana	3,438,389	14,233,986	13,500,000	14,014,000	13,000,000
Iowa	2,344,107	10,187,507	14,427,877	15,625,406	14,549,622
Kansas	692,823	5,544,048	5,610,000	6,010,000	5,017,117
Kentucky[1]	1,161,194	2,474,621	4,448,533	4,923,651	3,380,000
Louisiana	345,452	1,777,572	3,458,643	3,540,976	3,540,976
Maine	1,472,393	2,042,007	3,167,215	3,244,982	3,859,415
Maryland	873,471	6,000,052	5,560,000	6,083,682	5,750,135
Massachusetts	2,871,222	6,091,875	6,499,141	9,494,802	9,124,303
Michigan[1]	1,816,504	9,261,998	10,082,939	11,190,153	10,673,153
Minnesota	1,607,417	6,458,940	8,742,278	8,024,760	10,567,711
Mississippi	339,669	3,960,377	3,256,500	3,256,500	760,000
Missouri	1,570,801	5,513,049	7,982,860	7,374,933	7,154,400
Montana	308,744	2,888,401	3,475,569	3,356,869	3,924,950
Nebraska	494,886	1,796,278	4,500,000	4,603,400	3,855,828
Nevada	46,876	245,014	275,000	336,796	474,770
New Hampshire	872,606	1,590,464	2,045,410	2,238,705	2,004,685
New Jersey	3,274,811	7,208,287	5,784,354	6,280,897	6,708,922
New Mexico	35,458	556,399	828,952	845,867	1,314,192
New York[1]	3,937,739	23,231,964	19,901,391	21,685,131	20,715,131
North Carolina[1]	624,381	5,215,491	5,510,000	5,520,000	4,020,000
North Dakota	456,130	2,402,384	2,711,295	2,867,979	3,208,000
Ohio	4,776,318	14,334,246	12,992,625	12,017,104	14,499,834
Oklahoma	447,320	2,112,681	3,625,000	3,722,355	3,131,532
Oregon	649,718	5,310,467	5,955,662	5,711,000	6,830,276
Pennsylvania	4,887,266	10,424,580	10,985,392	11,463,333	14,753,876
Rhode Island	376,812	446,496	943,152	861,725	1,135,671
South Carolina	334,082	1,024,480	1,250,000	1,277,161	1,676,239
South Dakota	268,723	1,217,809	2,708,000	2,755,000	3,031,710
Tennessee	629,141	2,370,560	4,600,000	2,481,500	2,978,000
Texas	2,543,613	9,920,079	10,500,000	10,010,000	11,325,727
Utah	158,286	803,071	1,855,160	1,893,129	2,770,491
Vermont	567,397	1,023,941	1,607,800	1,680,489	1,606,075
Virginia	687,751	3,224,529	3,691,249	4,136,779	3,708,352
Washington	1,344,842	7,944,717	7,518,343	7,115,691	7,256,306
West Virginia	587,870	2,483,747	5,510,967	8,200,000	5,056,454
Wisconsin	1,924,026	9,880,240	10,570,764	9,886,554	9,284,175
Wyoming	74,476	669,661	450,000	589,691	929,215
Total	$ 59,427,180	$239,663,785	$ 272,634,424	279,915,332	$ 286,098,13

[1] Data for 1918 not available, States expenditures shown in 1918 column are for 1917.

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TABLE V.—*Progress of State Aid 1904 to 1918*

STATE	Year in Which First State-Aid Law Passed	STATE FUNDS EXPENDED BY OR UNDER STATE HIGHWAY DEPARTMENT				
		1904	1914	1916	1917	1918
Alabama	1911	.....	$ 170,232	$ 102,422	$ 89,511	$ 103,285
Arizona	1909	.....	.....	441,202	543,422	975,802
Arkansas	1913	.....	115,000	55,483	80,262	221,831
California	1895	$ 11,251	.....	4,285,964	3,058,030	6,941,192
Colorado	1909	.....	301,274	607,628	703,000	800,000
Connecticut	1895	219,165	1,307,381	1,865,948	2,197,264	3,172,706
Delaware	1903	14,000	31,000	31,000	21,600	429,734
Florida	1915	.....	.....	10,484	23,797	179,807
Georgia	1908	.....	.....	.....	1,910	15,000
Idaho	1905	.....	49,812	100,057	473,132	491,342
Illinois	1905	.....	387,989	1,119,202	1,258,338	860,911
Indiana	1917	.....	.....	.....	14,000	.....
Iowa	1904	.....	74,000	90,821	89,787	113,488
Kansas	1911	.....	9,080	10,000	10,000	25,000
Kentucky	1912	.....	18,000	708,346	1,501,650	1,000,000
Louisiana	1910	.....	161,186	184,533	182,295	182,295
Maine	1901	44,885	467,149	1,055,250	1,112,675	1,570,494
Maryland	1898	.....	356,845	2,280,000	2,804,707	2,681,142
Massachusetts	1892	575,606	242,560	2,701,236	4,231,802	3,522,494
Michigan	1905	.....	657,264	982,939	1,704,359	1,704,359
Minnesota	1905	.....	1,309,956	1,390,525	1,429,865	1,870,336
Mississippi	1915	.....	.....	6,500	6,500	10,000
Missouri	1907	.....	277,253	482,860	367,913	704,400
Montana	1913	.....	13,516	26,150	25,729	133,548
Nebraska	1911	.....	.....	110,000	9,500	201,202
Nevada	1911	.....	.....	.....	36,796	75,328
New Hampshire	1903	44,000	491,520	414,669	589,254	651,594
New Jersey	1891	250,000	1,306,596	1,167,843	1,501,902	1,848,932
New Mexico	1909	.....	115,732	385,684	280,578	527,072
New York	1898	1,056,460	8,544,126	9,409,655	9,432,679	9,432,679
North Carolina	1901	.....	5,000	10,000	20,000	20,000
North Dakota	1909	.....	.....	.....	28,638	.....
Ohio	1904	.....	1,855,338	2,885,071	2,835,649	83,000
Oklahoma	1911	.....	.....	300,000	286,922	4,670,270
Oregon	1913	.....	10,697	165,662	711,000	1,046,893
Pennsylvania	1903	127,767	1,976,768	3,663,352	4,351,566	2,120,551
Rhode Island	1902	79,397	.....	543,152	486,725	8,041,834
South Carolina	1917	.....	.....	.....	27,161	745,674
South Dakota	1911	.....	.....	.....	5,000	49,239
Tennessee	1915	.....	.....	200,000	231,500	30,473
Texas	1917	.....	.....	.....	10,000	403,000
Utah	1909	.....	157,732	179,400	120,200	295,567
Vermont	1898	127,381	458,456	632,800	578,883	1,546,843
Virginia	1906	.....	523,578	542,524	695,171	778,075
Washington	1905	.....	1,343,431	859,672	2,031,392	861,031
West Virginia	1909	.....	.....	10,967	.....	2,922,436
Wisconsin	1911	.....	1,482,379	950,000	1,050,888	171,581
Wyoming	1911	.....	.....	.....	37,845	2,051,455
Total and average	.....	$ 2,549,850	$ 24,220,850	$ 40,969,001	$ 47,290,796	$ 66,351,478

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The utilization of convict labor in road work or in the preparation of road materials under competent State supervision is coming to be a more and more important factor, while the employment of statute labor or working out of poll taxes is steadily decreasing from year to year. At the present time in more than one-half of our States the use of convict labor has definitely passed the experimental stage and has been established as a success.

One of the most notable features in the development of our road and bridge work is the increase in the amount of funds expended for road maintenance under the supervision and control of the several State highway departments. In 1914 the several State highway departments directed the expenditure of $16,343,000 for maintenance. In 1917 this had increased to $27,649,000, while in 1918 it reached a total of $34,974,908. This increase is in part due to the heavier traffic and the rising prices of labor and materials, but more largely to the growing tendency to centralize the control of all our important highway work under competent State control and supervision.

While highway construction during the year 1918 was considerably curtailed, especially by the local subdivisions, extraordinary traffic development required a large amount of improvement and reconstruction of a quite substantial nature. The reason for these construction demands is readily apparent. At the present time approximately 6,000,000 motor vehicles, of which about 10 per cent are motor trucks and other commercial vehicles, are used on our public roads and streets. If each of these vehicles averaged only 5,000 miles a year, which is certainly a low estimate, the total traffic of all our motor vehicles will amount to approximately 30,000,000,000 vehicle miles per year. Furthermore, it is a well-known fact that at least 75 per cent of the total traffic is concentrated on about 20 per cent of our rural public roads. Consequently, the reason why our roads are requiring so much greater expense and effort for adequate maintenance is readily apparent. This motor traffic, furthermore, has grown up almost entirely within the last 15 or 18 years and is entirely in addition to the horse-drawn traffic which, with the exception of pleasure vehicles, is probably as large as ever. At the present time the horse-drawn traffic on most of our roads forms less than 10 per cent of the total.

The public roads of the United States at the present time have a total length of 2,478,552 miles, of which about 299,135 are improved with some form of surfacing. A large portion of this mileage, however, is comprised of sand-clay, gravel, or water-bound macadam, much of which is proving entirely inadequate

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for the present-day traffic and is rapidly deteriorating. During 1918 there was improved by the several State highway departments a total of 11,944 miles, of which about 7,000 consisted of grading, most of which was preparatory to later surfacing. In addition to this construction the several State highway departments also supervised the maintenance of 203,556 miles, most of which were main and trunk-line highways.

The expenditures for 1918 by or under the various State highway departments are shown in Table 1 and the work accomplished is shown in 2 and 3. Table 5 shows the expenditures from purely State funds for the years 1904, 1914, 1916, 1917, and 1918, and No. 4 the total combined State and local expenditures for the same years. In Table 1 the columns under "administration" and "engineering" show a considerable variation in the percentage devoted to these purposes in each of the several States. These variations are probably due more to difference in bookkeeping and definition as to what items should be included under these heads than any other cause. There is a great need for common standards in regard to these items so that such expenditures may be fairly comparable as between the several States. This also applies to the term "reconstruction" and "maintenance." In some States practically all reconstruction work is classed under maintenance, while in others it is classed entirely under construction and in still others it is kept as a separate item and designated as reconstruction.

These compilations include no expenditures for road or street work by the War or Navy Departments and similar agencies in or at cantonments, training stations, or other places.

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PATENTS RELATING TO ROADS, AND ALLIED SUBJECTS [1] 1919

1,304,263 Road working machinery. M. R. Cole.
1,306,353 Road surfacing machine. R. E. Reynolds.
1,308,351 Excavating machinery. E. H. Granberry.
1,308,174 Road working machine. A. G. Dunnuck.
1,313,115 Road scraper. Edw. J. Robards.
1,313,873 Device for and method of installing joint-filling material in concrete or other types of pavement. John Avery.
1,314,308 Grader. Jacob F. DeLong.
1,314,810 Method of laying concrete pavements. T. H. Johnson.
1,315,749 Paving for streets and the like. R. C. Stubbs.
1,316,071 Process for making concrete. Edmund L. Zukoski.
1,317,059 Scraper. Warren Wing.
1,317,371 Ditching machine. D. C. Hottell.
1,317,601 Grader and ditcher. Wm. A. Steele.
1,317,602 Grader and ditcher. Wm. A. Steele.
1,318,093 Road grader. Wm. H. Lyons.
1,318,555 Road machine. R. H. Hawkins.
1,318,561 Double drag. Thos. F. Hudson.
1,318,679 Road machine. J. McLaughlin.
1,320,029 Apparatus for treating surfaces of roads. B. E. Savage and L. H. Hunter.
1,320,222 Apparatus for making roads. R. B. Gage.
1,320,328 Excavating machine. N. V. Haughton.
1,322,974 Road scraper or drag. H. G. Torke.
1,324,241 Grader and ditcher. L. Febre.
1,324,391 Paving guard. W. S. Goodwin.
1,325,601 Road surface. P. V. Adkins.
1,325,880 Scraper. Brude R. and Samuel J. Purviance.
1,289,782 Concrete paving machine. W. H. Hudson.
1,290,088 Road scraper. P. E. Clark.
1,290,332 Road drag. John L. Pascal.
1,290,862 Machine for forming paving brick. J. G. Anderson, R. H. James, and B. F. Cake.
1,291,361 Surfacing machine. Jacob Babst.
1,291,544 Apparatus for forming brick surfaced pavement. John F. Keenan.
1,291,705 Briqueting machine. W. D. Alexander.
1,291,981 Concrete mixer. Chresten T. Madsen.
1,291,635 Dredger. U. Bachman.
1,291,869 Brick molding and pressing machine. G. A. Peterson.
1,293,124 Briqueting press. C. Korte.
1,293,163 Concrete drain pipe. J. C. Mitchell and G. C. Bartram.
1,293,225 Rock drill. W. A. Smith.
1,293,937 Machine for making asphaltic or similar mixtures. N. M. Rosendahl.
1,293,961 Rock drill. Wm. A. Smith.
1,293,960 Rock drill. Wm. A. Smith.
1,294,042 Cement brick machine. H. K. Browning.
1,294,812 Land leveler. H. A. Lage.
1,295,576 Ditch digging machine. Kristoffer J. Nordby.
1,295,615 Excavating machine. G. Seeds.
1,296,295 Earth scraper and leveler. Henry A. Lage.
1,296,400 Road drag. Nels O. Johnson.
1,296,495 Concrete paving machine. D. Elder.
1,296,789 Scraper. H. B. Germeshausen.
1,296,807 Road machine. J. B. Jarmin.

[1] Completed by the United States Bureau of Public Roads.

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TRACTIVE RESISTANCE TESTS SHOW ECONOMY OF THE IMPROVED ROAD SURFACE [1]

ECONOMY OF THE IMPROVED ROAD SURFACE

	Pounds pull per ton	*Miles per hour*	*Miles per gallon*
Dirt Road	92 to 218	4.6	5.78
Gravel	78.2–81.3	9.5	7.19
Macadam	64.3	..	9.48
Paved Road	27.6	16.4	11.44–11.78

Wayne county, Michigan, tractive resistance tests supplementing the data secured by the Good Road Section of Iowa State College on Iowa paved surfaces show that while it takes 218 pounds pull to move a ton on earth road, the same load can be moved on a hard paved surface with a 27.6 pounds pull. These figures are given out by Edward N. Hines, chairman of the Board of County Road Commission of Wayne county, Michigan, a county where all new road construction on main roads for the past twelve years has been of concrete or brick, but chiefly of concrete.

A test with a two-ton truck shows that while on dirt road a speed of 4.6 miles could be maintained, on the paved surfaces the speed rose to 16.4 miles. This test was made on the road from Detroit to Jackson and Ann Arbor.

A test made in the vicinity of Cleveland, Ohio, showed 5.78 miles per gallon on dirt road for a two-ton truck and 11.78 miles on a paved road.

Tractive resistance tests are in progress in Iowa, having started early in 1919. The tests will give data on miles per gallon, pounds pull per ton and speed on the various types of road met with under Iowa conditions.

[1] Reproduced from the Service Bulletin, Iowa State Highway Commission.

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N. A. C. C. HORSEPOWER RATING

The standard horsepower rating, formerly known as the A. L. A. M. rating, has been officially adopted by the National Automobile Chamber of Commerce, Inc.

The formula adopted is $\frac{D^2 \times N}{2.5}$. D is the cylinder bore in inches, N the number of cylinders, and 2.5 a constant, based on the average view of eminent engineers as to a fair, conservative rating for a four-cycle motor at 1,000 feet per minute piston speed.

Table of Horsepower for Usual Sizes of Motors

Ins.	2 Cylinders	4 Cylinders	6 Cylinders	8 Cylinders	12 Cylinders
2 1/2	5.00	10.00	15.00	20.00	30.00
2 5/8	5.50	11.03	16.54	22.05	33.08
2 3/4	6.00	12.10	18.15	24.20	36.30
2 7/8	6.62	13.23	19.84	26.45	39.68
3	7.20	14.40	21.60	28.80	43.20
3 1/8	7.81	15.63	23.44	31.25	46.88
3 1/4	8.50	16.90	25.35	33.80	50.70
3 3/8	9.12	18.23	27.34	36.45	54.68
3 1/2	9.80	19.60	29.40	39.20	58.80
3 5/8	10.50	21.03	31.54	42.05	63.08
3 3/4	11.25	22.50	33.75	45.00	67.50
3 7/8	12.00	24.03	36.04	48.05	72.08
4	12.80	25.60	38.40	51.20	76.80
4 1/8	13.62	27.23	40.84	54.45	81.68
4 1/4	14.50	28.90	43.35	57.80	86.70
4 3/8	15.31	30.63	45.94	61.25	91.88
4 1/2	16.20	32.40	48.60	64.80	97.20
4 5/8	17.12	34.23	51.34	68.45	102.68
4 3/4	18.00	36.10	54.15	72.20	108.30
4 7/8	19.00	38.03	57.04	76.05	114.08
5	20.00	40.00	60.00	80.00	120.00
5 1/8	21.00	42.03	63.04	84.05	126.08
5 1/4	22.00	44.10	66.15	88.20	132.30
5 3/8	23.00	46.23	69.34	92.45	138.68
5 1/2	24.20	48.40	72.60	96.80	145.20
5 5/8	25.31	50.63	75.94	101.25	151.88
5 3/4	26.50	52.90	79.35	105.80	158.70
5 7/8	27.62	55.23	82.84	110.45	165.68
6	28.80	57.60	86.40	115.20	172.80

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HORSEPOWER OF STANDARD MAKES OF GASOLENE PASSENGER AND COMMERCIAL VEHICLES

PASSENGER CARS

	No. of Cylinder	Bore Inches	Horse Power N.A.C.C. Rating
Allen	4	3½	19.60
American Beauty E-6-48 & G-6-48	6	3¼	25.35
American Beauty	6	3½	29.40
American Beauty	6	3⅜	23.44
Anderson	6	3¼	25.35
Apperson (all models)	8	3¼	33.80
Auburn (all models)	6	3¼	25.35
Austin	12	2½	39.68
Beggs	6	3¼	25.35
Bell	4	3¾	22.50
Biddle	4	3¾	22.50
Birch	4	3⅜	15.63
Birch	4	3½	19.60
Birch	6	3⅜	23.44
Bour-Davis	6	3¼	25.35
Brewster	4	4	25.60
Briscoe 4-24	4	3 3/16	.....
Briscoe 4-34	4	3¾	18.23
Buick (all models)	6	3⅜	27.34
Cadillac	8	3⅛	31.25
Cadillac 57	8	3	28.80
Cameron 55	6	2 15/16	.....
Case (all models)	6	3½	29.40
Chalmers	6	3¼	25.35
Champion C-6	6	3⅜	23.44
Champion C-4	4	3½	19.60
Chandler	6	3½	29.40
Chevrolet (all models)	4	3 11/16	.....
Cleveland (all models)	6	3	21.60
Climber 6-50	6	3½	29.40
Climber 4-40	4	3¼	16.90
Cole (all models)	8	3½	39.20
Columbia	6	3¼	25.35
Comet	6	3½	29.40
Commonwealth	4	3½	19.60
Crawford	6	3½	29.40
Crow-Elkhart Sedan	6	3⅛	23.44
Crow-Elkhart Touring	4	3½	19.60
Cunningham (all models)	8	3¾	45.00
Daniels	8	3½	39.20
Davis	6	3¼	25.35
Dixie (all models)	4	3¼	16.90
Dodge (all models)	4	3⅛	24.03
Dorris	6	4	38.40
Dort (all models)	4	3½	19.60
Douglas	8	3¼	33.80
Dupont	....	3 15/16	.....
Economy	6	3¼	25.35
Elcar 6 and D-6	6	3¼	25.35
Elcar 4 and G-4	4	3½	19.60
Elgin	6	3⅜	23.44
Essex	4	3⅛	18.23
Fiat Touring 501	4	2 9/16	.....
Fiat Brougham	4	3	14.40
Fiat Touring 510	6	3	21.60
Ford (all models)	4	3¼	22.50
Franklin	6	3¼	25.35
Franklin 9-B	6	3½	29.40
Gardner	4	3½	19.60
Geronimo	6	3⅜	23.44
Glide Touring	6	3⅜	23.44
Grant Touring H	6	3 1/16	.....
Grant Touring	6	3⅜	23.44
Hackett	4	3½	19.60
Halladay	6	3⅜	23.44
Hanson	6	3¼	25.35
Harroun	4	3¼	16.90
Harvard	4	3	14.40
Hatfield	4	3¼	16.90
Haynes Light Touring	6	3½	29.40
Haynes Light Sedan	12	2¾	36.30
Hollier	6	3¼	25.35
Holmes	6	3½	29.40
Hudson	6	3½	29.40
Hupmobile	4	3½	16.90
Jackson	6	3¼	25.35
Jones	6	3½	29.40
Jordan M	6	3¼	25.35
Jordan F	6	3½	29.40
King	8	3	28.80
Kissel	4	3 5/16	.....
Kissel Kar	6	3 5/16	.....
Kline Kar	6	3¼	25.35
Leach	6	3½	29.40
Lexington	6	3¼	25.35
Liberty	6	3⅜	23.44
Liberty	6	3¼	25.35
Locomobile	6	4½	48.60
Lorraine	4	3½	19.60
McFarlan (all models)	6	4½	48.60
Maibohm	6	3⅜	23.44
Marmon	6	3¾	33.75
Maxwell	4	3⅛	21.03
Mercer	4	3¾	22.50
Metz	6	3⅜	23.44
Mitchell E-40	6	3¼	25.35
Mitchell E-42	6	3½	29.40
Moline-Knight	4	3¼	22.50

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	No. of Cylinder	Bore Inches	Horse Power N.A.C.C. Rating
Moline-Knight	6	3½	29.40
Monitor	6	3½	25.35
Monroe	4	3¼	16.90
Moon 6-48 and Victory	6	3¼	25.35
Moon Touring and 6-66	6	3½	29.40
Moore	4	3¾	22.50
Nash	6	3½	25.35
Nash	6	3½	29.40
National	6	3½	29.40
Nelson	4	3½	15.63
Noma	6	3¼	25.35
Oakland	6	2 13/16	.....
Oldsmobile 37-A	6	2 13/16	.....
Oldsmobile 45-B	8	2¾	26.45
Oldsmobile 45-B	8	3¼	48.05
Olympian	4	3½	16.90
Overland 90	4	3½	18.23
Overland	4	3¼	16.90
Owen-Magnetic	6	4	38.40
Packard (all models)	12	3	43.20
Paige 6-55 and Sport	6	3½	29.40
Paige 6-39, 6-40, 15-19 and Touring	6	3½	23.44
Paterson	6	3¼	25.35
Peerless(all models)	8	3¼	33.80
Phianna	4	3 29/32	.....
Piedmont	4	3½	19.60
Piedmont	6	3¼	25.35
Pierce-Arrow 38	6	4	38.40
Pierce-Arrow 48	6	4½	48.60
Pilot	6	3½	23.44
Porter	4	4 6/10	.....
Premier	6	3½	27.34
Reo	6	3 3/16	.....
Revere	4	4½	30.63
Roamer (all models)	6	3½	29.40
R & V Knight J	6	3½	29.40
R & V Knight R & L	4	3¾	22.50
R & V Knight G	4	4	25.60
Saxon Touring	4	3½	15.63
Saxon Y-18	6	2½	19.84
Sayers Touring	6	3¼	25.35
Sayers Six 1920	6	3¼	29.40
Scripps-Booth (all models)	6	2 13/16	.....
Seneca H, H-2	4	3½	15.63
Simplex - Crane Limousine	6	4½	45.94
Singer (all models)	6	4	38.40
Spacke	2	3½	9.80
Standard H	8	3¼	33.80
Stearns SKL-4	4	3¾	22.50
Stearns - Knight Sedan	4	3¾	22.50
Stephens Salient Six	6	3¼	25.35
Studebaker E. G.	6	3½	36.04
Studebaker Special Touring and E H	6	3½	29.40
Studebaker Big Touring	6	3½	36.04
Studebaker SH-4	4	3½	19.60
Stutz	4	4¾	30.63
Stutz G	4	3½	18.23
Templar (all models)	4	3½	18.23
Tulsa D	4	5	40.00
Tulsa D-1	4	3½	19.60
Velie 34	6	3½	23.44
Velie 48	6	3¼	25.35
Wescott Touring C-38 and B-38	6	3¼	25.35
Wescott Touring C-48 and A-48	6	3½	29.40
Willys-Knight 88-4	4	4½	27.23
Willys-Knight	4	3½	21.03
Winton 24	6	4½	48.60
Winton 25	6	3¾	33.75
Winston 25	6	3¼	33.75

TRUCKS

A & B (all models)	4	5	40.00
Acason, H, L and Tractor	4	4¼	28.90
Acason, M & Tractor	4	4¾	36.10
Acason, R	4	3½	16.90
Acason, RB	4	3¾	22.50
Ace	4	3¾	22.50
Ace	4	4¼	28.90
Acme, B	4	3¾	22.50
Acme, A	4	4½	27.23
Acme, C	4	4½	32.40
Acme, E	4	4¾	36.10
All American AA	4	3¼	16.90
American 2 and 3½ ton	4	4¼	28.90
American 5 ton	4	4½	32.40
American LaFrance Aerial Hook and Ladder Truck	4 or 6	5½	48.40 72.60
American La France Triple Combination Pumping Car	4 & 6	5½	48.40 & 72.60
Apex C 1 ton and D 1½ ton	4	3¼	19.60
Apex, E 2½ ton	4	4¼	28.90
Armleder, HW	4	4	25.60
Armleder, KW	4	4½	32.40
Atco	4	4¼	28.90
Atlas, 19	4	3½	19.60
Atterbury 7R and 7C	4	4¼	27.23
Atterbury, 7D	4	4½	32.40
Atterbury, 8E	4	4¾	36.10
Autocar, 21-F	2	4¾	18.00
Available, 2	4	4½	27.23
Available, 3 and 5	4	4½	32.40
Beck, A	4	3½	19.60
Beck, B	4	3¾	22.50
Beck C	4	.....	.....
Beech Creek, 3A	4	4¼	28.90

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	No. of Cylinder	Bore Inches	Horse Power N.A.C.C. Rating
Bell	4	3¾	22.50
Bell	4	4½	32.40
Bessemer, G	4	3½	19.60
Bessemer, H	4	3¾	22.50
Bessemer, J-2	4	4⅛	27.23
Bessemer, K	4	4½	32.40
Bethlehem, D	4	3¾	22.50
Bethlehem, E	4	4	25.60
Bethlehem, F	4	4⅛	30.63
Bethlehem, FJ	4	4½	32.40
Brinton, H	4	3½	16.90
Brinton, F	4	4⅛	27.23
Briscoe, 4-24	4	3 3/16	.....
Briscoe, T-34	4	3⅛	18.23
Brockway, S	4	3¾	22.50
Brockway, K3	4	4⅛	27.23
Brockway, R	4	4½	32.40
Brockway, T	4	4¾	36.10
Chevrolet, T	4	3 11/16	.....
Clydesdale, 42 and 65	4	4⅛	27.23
Clydesdale, 90	4	4½	32.40
Clydesdale, 120B	4	4¾	36.10
Collier	4	3½	19.60
Collier	4	3¾	22.50
Columbia, F	4	3¾	22.50
Columbia, E and T	4	4⅛	27.23
Comet	4	3½	19.60
Commerce (all models)	4	3¾	22.50
Concord, A	4	3¾	22.50
Concord, B	4	4¼	28.90
Corbitt, D and E	4	3¾	22.50
Corbitt, B and C	4	4⅛	27.23
Corbitt, AA and A	4	4½	32.40
Corliss, A	4	3⅛	15.63
Couple-Gear, HO	4	4¾	36.10
Couple-Gear, AO	4	5¼	44.10
Croce, 17	4	3¼	16.90
Dart, E	4	3¾	22.50
Dart, CC4	4	4¾	36.10
Dart, L	4	4¼	32.40
Day-Elder, J	4	3⅛	15.63
Day-Elder, A	4	3½	19.60
Day-Elder, B	4	3¾	22.50
Day-Elder, D	4	4⅛	27.23
Day-Elder C	4	4¼	28.90
Day-Elder, E & F	4	4½	32.40
Defiance, B	4	3¾	22.50
Defiance, C	4	4¾	36.10
DeKalb (all models)	4	4⅛	27.23
Denby, 12	4	3½	19.60
Denby, 134	4	3¾	22.50
Denby, 25	4	4⅛	27.23
Denby, 27 and 210	4	4½	32.40
Dependable	4	3¾	22.50
Dependable	4	4¼	28.90
Diamond-T, J5	4	3½	19.60
Diamond-T, J4	4	3¾	22.50
Diamond-T, J3	4	4⅛	27.23
Diamond-T, LB and R	4	4½	32.40
Diehl, A	4	3½	19.60
Doane	4	4¼	28.90
Doane	4	4¾	36.10
Dodge	4	3⅛	24.03
Dorris (all models)	4	4¼	28.90
Douglas, D	4	4⅛	27.23
Duplex, A	4	4	25.60
Duplex, E	4	4¼	28.90
Ellsworth, 25A	4	3¼	16.90
Fageol	4	4	25.60
Fargo, P	4	3¾	22.50
Famous, B10	4	3½	19.60
Famous, B12	4	3¾	22.50
Federal, S	4	3¾	22.50
Federal, T, U and Trac.	4	4⅛	27.23
Federal, W, X and Trac.	4	4½	32.40
Forschler, ¾ ton	4	3⅛	15.63
Forschler	4	3½	19.60
Forschler, 2 ton	4	4⅛	27.23
Ford, TT	4	3¾	22.50
F. W. D., B	4	4¾	36.10
Fulton, FX	4	3⅛	18.23
Fulton, C	4	3½	16.90
Garford	4	4½	32.40
Garford, 75-C, 25 & 66-B	4	3¾	22.50
Garford, 70-B and Trac. 70-B	4	4¼	28.90
Garford, 77-C and 68 and Trac. 77	4	4¾	36.10
Garford, 69 and Trac. 68	4	5 1/10	.....
Gary, G	4	4	25.60
Gary, HT and K	4	4½	32.40
Gary, M	4	5	40.00
Globe, A	4	3½	19.60
Globe, B	4	3¾	22.50
Globe, C	4	4⅛	27.23
G. M. C., 16 and 31	4	3¾	22.50
G. M. C., 41	4	4⅛	27.23
G. M. C., 71 and 101	4	4½	32.40
Graham	4	3¾	22.50
Gramm-Bernstein	4	4¾	36.10
Gramm-Bernstein	4	4⅛	27.23
Gramm-Bernstein	4	4¼	28.90
Gramm-Bernstein	4	4½	32.40
Grant, 12	4	3½	16.90
Grant, 10	4	3¾	22.50
Grant, 11, 15 and 16	4	3¾	22.50
Hahn, G	4	3½	19.60
Hahn, C	4	4⅛	27.23
Hahn, E	4	4½	32.40
Hall	4	4⅛	27.23
Hall 3½, 5 and 7 ton	4	4½	32.40
Harvey, WEA	4	4⅛	27.23
Harvey, WFA & WHA	4	4¼	28.90
Harvey, WKA & Trac., HT	4	4½	32.40
Hawkeye, K	4	3¾	22.50
Hawkeye, M	4	4¼	28.90
Hendrickson	4	4¼	28.90
Hendrickson	4	4½	32.40
Highway KN'T, A	4	4	25.60
Higrade (all models)	4	3½	19.60

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	No. of Cylinder	Bore Inches	Horse Power N.A.C.C. Rating
Hoover, 15-B	4	3½	19.60
Huffman (all models)	4	3¾	22.50
Hupmobile	4	3½	16.90
Hurlburt	4	4½	28.90
Hurlburt, 3½ and 5 ton	4	4½	32.40
I. H. C., F, H and K	4	3½	19.60
I. H. C., G	4	4	25.60
Indiana, T	4	3½	22.50
Indiana, 12 1¾ ton, 12 2 ton and 25	4	4½	27.23
Indiana, 35	4	4¾	30.63
Indiana, L	4	4¾	36.10
International	4	4	25.60
Jackson	4	4½	32.40
Jones, 31-A	4	3¾	22.50
Jumbo, 15 and 20	4	3¾	22.50
Jumbo, 25 and 30	4	4½	28.90
Jumbo, 35 and 40	4	4½	32.40
Kalamazoo, G	4	3¾	22.50
Kalamazoo, H	6	3½	29.40
Kalamazoo, K	6	3¾	33.75
Kankakee, E	6	3½	29.40
Kearns ½ and 1½ ton	4	3¾	16.90
Keldon, 19	4	4¼	28.90
Kelly-S., K-31, K-32, K-35 and K-36	4	3¾	22.50
Kelly-S., K-40, K-45, K-50 and K-60	4	4½	32.40
Keystone, 40	.....	4	.....
Kimball, A and B	4	4	25.60
Kimball, C	4	4½	28.90
Kimball, E	4	4¾	36.10
Kimball, F	4	5.1	.....
Kissel	4	3⅞	24.03
Kissel 2, 3½ and 5 ton	4	4½	28.90
Kleiber, AA	4	3¾	22.50
Kleiber, A	4	4½	27.23
Kleiber, BB	4	4½	28.90
Kleiber, B and C	4	4½	32.40
Kleiber, D	4	5¼	44.10
Koehler, K and Trac. CT	4	3½	19.60
Koehler, M and Trac. MT	4	4	25.60
LaFrance (all models)	4	4½	27.23
Larrabee, U	4	3¾	22.50
Larrabee, C-D	4	4½	27.23
Larrabee, A and T	4	4½	32.40
L. M. C	4	4½	27.23
Lombard, S	6	5¾	79.35
Maccar, S	4	4¾	36.10
Maccar, L	4	4½	27.23
Maccar, H and M	4	4½	32.40
Maccar, U	4	5.1	.....
Mack, AB 1½, 2 and 5 ton	4	4	25.60
Mack, AC, 3½, 5½, 7, 7½ 11 and 15 ton	4	5	40.00
Master, JI and JW	4	4½	27.23
Master, M, O, W, and WL	4	4½	28.90
Master, A and B	4	4½	32.40
Maxwell	4	3¾	21.03
Menominee, 1 and 1½ ton	4	3¾	22.50
Menominee, D 2 ton	4	4½	27.23
Menominee, G 3½ and J 5 ton	4	4½	32.40
Modern, 30	4	3¾	22.50
Moreland, 19-B	4	4½	27.23
Moreland, 19-C	4	4½	32.40
Moreland, 19-G and 19-J	4	4¾	36.10
Muskegon, 20	4	4½	27.23
Mutual	4	4¾	28.90
Mutual	4	4¾	36.10
Myers, 50, 55, 70 and 75	4	3½	19.60
Napoleon, 9 and 11	4	3½	19.60
Nash, 2018 and 3018	4	3¾	22.50
Nash, 4017	4	4¼	28.90
Nelson & LeM., F	4	3¾	22.50
Nelson & LeM., F2	4	4½	27.23
Nelson & LeM., F and 5 ton	4	4½	32.40
Netco, D	4	4½	27.23
Netco, H	4	4½	32.40
Noble, NW2	4	4½	27.23
Noble, NW4	4	4½	32.40
Northway (all models)	.....	4	.....
Norwalk, 2,000 and 3,000	4	3½	19.60
Ogden	4	3¾	22.50
O. K. 1½ ton and 2 ton	4	4½	27.23
O. K. 3 ton	4	4½	28.90
Old Hickory, M	4	3½	16.90
Old Reliable, W-15	4	4	25.60
Old Reliable, W-25 and W-35	4	4½	28.90
Old Reliable, W-50	4	5.1	.....
Old Reliable, C-50 and C-70	4	4¾	36.10
Oldsmobile	4	3 11/16	.....
Oneida, A	4	3¾	22.50
Oneida, B & C	4	4½	27.23
Oneida, B9	4	4	25.60
Oneida, D and E-9	4	4½	32.40
Oneida, E	4	5½	44.10
Oshkosh	4	3½	19.60
Overland, Panel and Exp	4	3½	18.23
Overland	4	4½	27.23
Packard, E 1½ and 2 ton	4	4	25.60
Packard, E 3 and 4 ton	4	4½	32.40
Packard, E 5 and 6 ton	4	5	40.00
Paige, 50	4	4½	27.23
Paige, 51	4	4½	32.40

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	No. of Cylinder	Bore Inches	Horse Power N.A.C.C. Rating
Parker, F-9, WC..	6	3½	29.40
Parker, F-9, W....	4	4	25.60
Parker, 3½ ton and J-9.	4	4½	32.40
Parker, M-9.....	4	4¾	36.10
Patriot.....	4	3¾	22.50
Patriot.....	4	4⅛	27.23
Peerless (all models).....	4	4½	32.40
Pierce-Arrow, X-4.	4	4	25.60
Pierce Arrow, R-9.	4	4⅞	38.03
Power.....	4	4⅛	27.23
Rainier, R-11 and R-6...	4	3½	19.60
Rainier, R-8.....	4	3¾	22.50
Reliance, 10.....	4	4⅛	27.23
Reliance, 20.....	4	4¾	28.90
Reo, F.....	4	4⅛	27.23
Republic, Desp....	4	3¾	16.90
Republic, 9 Sp., 10 & 11X.	4	3¾	22.50
Republic, 19.....	4	4⅛	27.23
Republic, 20.....	4	4½	32.40
Riker (all models).	4	4¼	28.90
Rowe, CDW 2, CDW 2½ and DEW 3 ton.....	4	4	25.60
Rowe, GW 3 ton..	8	3½	33.80
Rowe, FW 5 ton..	4	4½	36.10
Royal, 1 ton.....	4	3½	16.90
Royal, 1½ ton....	4	3¾	22.50
Royal, 2 ton.....	4	4	25.60
Royal, 2½ ton....	4	4¼	28.90
Royal, 3½ ton....	4	4½	32.40
Royal, 5 ton.....	4	4¾	36.10
Royal, 6 ton.....	4	5⅛	42.03
Royal, 7 ton.....	4	5¼	44.10
Sandow, G and CG	4	3½	19.60
Sandow, J.....	4	4⅛	27.23
Sandow, 2 ton.....	4	3¾	22.50
Sandow, K.....	4	4½	32.40
Sandow, L.....	4	4¾	36.10
Sanford, 25.....	4	4⅛	27.23
Sanford, 35 and 50.	4	4½	32.40
Schacht, 2, 2½ and 3½ ton.....	4	4¼	28.90
Schacht, 5 ton....	4	4½	32.40
Schleicher.....	4	4¼	28.90
Schleicher.....	4	5	40.00
Selden, TXR, TWL and TXL.....	4	3½	19.60
Selden.....	4	3¾	22.50
Selden, JCB, JWB and A.....	4	4⅛	27.23
Selden, NL and DL....	4	4½	32.40
Seneca, J.....	4	3½	15.63
Service, 220.....	4	3½	19.60
Service, 31.....	4	4	25.60
Service, 36, 51 and 71...	4	4¼	28.90
Service, 76 and 101.....	4	4½	32.40
Shaw, M-3.....	4	4⅛	27.23
Signal, F, H and J.	4	4⅛	27.23
Signal, M.....	4	4½	32.40
Signal, R.....	4	4¾	36.10
Standard, 56.....	4	3¾	22.50
Standard, 76.....	4	4⅛	27.23
Standard, 66 and 86.....	4	4½	32.40
Steele, C.....	4	4⅛	27.23
Steele, B, BA and A....	4	5	40.00
Sterling, 2½ ton...	4	4¾	30.63
Sterling, 2½ ton and 3½ ton.....	4	4¼	28.90
Sterling, 5 ton and 7 ton.	4	4¾	36.10
Stewart, 11.....	4	3½	15.63
Stewart, 8.....	4	3½	19.60
Stewart, 9.....	4	3¾	22.50
Stewart, 7.....	4	4⅛	27.23
Stewart, 10.....	4	4½	32.40
Sullivan, F.....	4	3¾	22.50
Sullivan, E.....	4	4⅛	27.23
Super Truck, 50...	4	4	25.60
Super Truck, 70...	4	4¼	28.90
Super Truck, 100..	4	4¾	36.10
Superior, A.....	4	3½	19.60
Superior, C.....	4	3¾	22.50
S. V., 4.....	4	4½	32.40
Texan.....	.....	.....	.....
Tiffin, A.....	4	3½	19.60
Tiffin, GW.....	4	3¾	22.50
Tiffin, MW.....	4	4⅛	27.23
Tiffin, PW.....	4	4½	32.40
Tiffin, RW and SW	6	3¾	33.75
Titan, T and H...	4	4½	32.40
Tower, F.....	4	4⅛	27.23
Tower, G.....	4	4½	32.40
Traffic.....	4	3¾	22.50
Transport, 20, 30 and N....	4	3¾	22.50
Transport, 50.....	4	4⅛	27.23
Triangle, A.....	4	3¾	22.50
Triangle, B.....	4	4⅛	27.23
Union, B.....	4	4½	28.90
Union, C.....	4	4½	32.40
U. S., E and H...	4	4⅛	27.23
U. S., D.....	4	.....	.....
U. S., J.....	4	4½	32.40
U. S., K.....	4	4¾	36.10
United, AX.....	4	3¾	22.50
United, BX.....	4	4¼	28.90
United, CX and VX....	4	4½	32.40
Universal, G.....	4	3¾	22.50
Universal, D & L..	4	4¼	28.90
Velie, 25B.....	4	4⅛	27.23
Velie, 26B.....	4	4½	32.40
Vim, 21 and 26....	4	3	14.40
Vim, 22 and 25....	4	3¾	22.50
Vim, 23.....	4	4¼	28.90
Walker-Johnson, B	4	4¼	28.90
Walter, MO.....	4	4⅜	30.63
Walter, F.....	4	4½	32.40
Watson, Tractor...	4	4½	32.40
White, 15, 20 and 40.....	4	3¾	22.50
White, 45.....	4	4¼	28.90

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	No. of Cylinder	Bore Inches	Horse Power N.A.C.C. Rating
Wichita, L.	4	3 1/2	19.60
Wichita, M and R.	4	3 3/4	22.50
Wichita, O and S. .	4	4 1/2	32.40
Wilcox, A.	4	3 3/4	22.50
Wilcox, B, C and D	4	4 1/4	28.90
Wilcox, E.	4	4 3/4	36.10
Wilson, 1 ton.	4	3 1/2	19.60
Wilson, 2 ton.	4	4 1/8	27.23
Wilson, 3 1/2 and 5 ton. . .	4	4 1/2	32.40
Winther, 39.	4	3 3/4	22.50
Winther, 49, 69 and 459. .	4	4	25.60
Winther, 89 & 479.	4	4 1/4	28.90
Winther, 109.	4	4 3/4	36.10
Winther, 129 & 149	4	5 1/8	42.03
Winther, 439.	4	3 1/2	19.60
Wisconsin, B.	4	3 1/2	19.60
Wisconsin, C.	4	4	25.60
Witt-Will, Wd-18. .	4	3 3/4	22.50
Witt-Will, WD-18.	4	4 1/8	27.23
Wolverine, C.	4	3 3/4	22.50

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REGISTRATION OF CARS, TRUCKS AND MOTORCYCLES, DECEMBER 31, 1919*

STATE OR TERRITORY	Gross Car and Truck Registration	Gasoline Passenger Cars	Gasoline Commercial Cars	Motor-Cycles	Total Fees
Alabama	58,898	48,649	10,249	1,103	$ 471,000
Arizona	28,979	.....	.....	596	164,747
Arkansas	49,448	.....	.....	.....	494,480
California	493,463	.....	.....	28,038	4,468,722
Colorado	104,366	.....	.....	3,268	491,009
Connecticut	105,600	83,500	22,100	4,450	1,540,724
Delaware	16,152	.....	.....	690	286,329
District of Columbia	28,940	15,332	3,128	468	146,515
Florida	56,253	49,014	7,239	1,416	360,000
Georgia	126,563	117,313	9,250	1,528	417,096
Idaho	41,780	.....	.....	572	729,363
Illinois	478,438	.....	.....	10,988	3,265,083
Indiana	277,255	.....	.....	8,996	1,558,740
Iowa	363,000	.....	.....	3,080	2,750,000
Kansas	228,601	.....	.....	3,589	1,150,183
Kentucky	90,008	80,903	9,105	1,502	529,710
Louisiana	50,000	.....	.....	.....	300,000
Maine	53,424	47,632	5,792	1,604	685,335
Maryland	98,995	87,989	8,806	5,872	1,746,414
Massachusetts	288,059	234,755	53,304	13,831	3,252,328
Michigan	325,813	288,708	37,105	7,875	3,522,069
Minnesota	259,743	.....	.....	6,389	1,296,870
Mississippi	45,030	42,660	2,370	2,370	330,000
Missouri	244,427	.....	.....	4,131	1,725,077
Montana	59,312	.....	.....	847	406,573
Nebraska	200,100	.....	.....	2,500	275,000
Nevada	9,305	.....	.....	155	47,550
New Hampshire	30,008	.....	.....	2,680	515,000
New Jersey	189,167	169,849	19,318	11,377	2,841,048
New Mexico	20,000	.....	.....	300	115,000
New York	555,789	440,043	115,746	27,988	5,881,623
North Carolina	109,000	.....	.....	1,455	1,280,000
North Dakota	82,886	.....	.....	903	636,764
Ohio	516,225	.....	.....	20,444	2,680,000
Oklahoma	151,300	.....	.....	.....	1,208,594
Oregon	83,332	.....	.....	3,570	602,064
Pennsylvania	490,337	449,444	40,893	25,760	5,090,645
Rhode Island	39,563	32,411	7,152	2,967	175,000
South Carolina	70,143	.....	.....	869	389,035
South Dakota	104,625	.....	.....	888	300,000
Tennessee	80,422	.....	.....	1,133	500,000
Texas	329,700	.....	.....	3,872	2,601,478
Utah	35,144	.....	.....	.....	291,349
Vermont	26,807	24,450	2,400	800	460,191
Virginia	95,000	.....	.....	2,420	800,000
Washington	168,146	.....	.....	.....	2,291,264
West Virginia	50,203	.....	.....	994	862,557
Wisconsin	236,974	226,094	10,880	7,223	2,468,732
Wyoming	21,371	.....	.....	.....	102,115
Totals	7,668,094	2,438,746	364,837	231,501	$64,503,376

*Compiled by Automotive Industries January 15, 1920.

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REGISTRATION OF CARS AND TRUCKS FOR EIGHT YEARS*

	Dec. 31, 1912	Dec. 31, 1913	Dec. 31, 1914	Dec. 31, 1915	Dec. 31, 1916	Dec. 31, 1917	Dec. 31, 1918	Dec. 31 1919
Albama	3,385	5,435	8,425	13,798	22,354	32,873	46,171	58,898
Arizona	1,624	3,445	4,774	7,320	12,122	19,890	23,905	28,979
Arkansas	2,250	3,000	5,642	8,021	14,704	28,862	41,458	49,488
California	88,699	60,000	123,101	163,801	212,918	243,116	407,761	493,463
Colorado	8,950	13,000	17,951	26,611	44,180	66,850	83,244	104,366
Connecticut	17,950	23,263	26,218	38,950	56,048	74,642	86,067	104,600
Delaware	1,732	2,373	2,894	4,924	7,520	9,655	12,955	16,152
District of Columbia	11,902	15,625	8,000	10,200	13,118	21,198	30,490	18,460
Florida	6,749	8,372	11,366	13,123	14,220	39,216	54,186	56,253
Georgia	19,120	18,500	20,800	24,059	45,775	70,496	104,676	126,563
Idaho	2,500	2,173	3,272	7,093	12,996	24,316	32,289	41,780
Illinois	68,073	94,656	131,140	182,290	251,300	340,292	389,620	478,438
Indiana	54,334	44,738	65,500	96,915	139,138	189,433	227,160	277,255
Iowa	47,188	70,294	106,087	139,808	172,791	278,213	278,313	363,000
Kansas	22,000	34,366	50,467	74,956	114,364	154,442	189,163	228,601
Kentucky	5,147	7,210	11,746	19,500	31,500	47,400	65,884	90,008
Louisiana	7,000	7,200	3,500	10,880	20,014	31,650	40,000	50,000
Maine	7,743	10,570	14,300	18,600	28,951	38,499	40,372	49,401
Maryland	10,487	14,254	20,213	27,638	33,364	56,129	74,666	98,995
Massachusetts	51,229	60,826	76,832	89,133	136,790	155,044	193,497	288,059
Michigan	39,579	54,366	76,389	114,845	159,639	215,001	262,125	296,378
Minnesota	29,000	37,800	67,365	91,829	137,500	191,500	204,458	259,743
Mississippi	2,895	3,000	3,894	11,500	20,474	31,650	48,400	45,030
Missouri	24,379	38,140	50,998	76,462	107,865	146,142	188,040	229,577
Montana	2,000	5,686	10,706	14,520	24,585	41,896	51,053	58,117
Nebraska	33,861	47,274	50,000	59,140	101,201	148,101	173,374	200,100
Nevada	900	1,131	1,487	2,177	4,609	6,760	8,159	9,305
New Hampshire	5,764	7,420	8,738	10,819	14,338	18,146	24,817	30,008
New Jersey	35,439	39,288	58,820	67,556	75,108	87,421	155,519	189,167
New Mexico	911	1,721	3,090	4,947	8,028	14,086	17,647	20,000
New York	105,546	122,411	156,173	212,844	279,406	404,247	459,292	555,789
North Carolina	6,178	10,000	14,815	21,160	35,150	55,950	72,313	109,000
North Dakota	8,975	12,968	17,348	24,678	41,761	62,993	71,618	82,886
Ohio	63,066	86,054	121,265	179,767	252,179	333,630	412,775	500,924
Oklahoma	6,524	7,934	7,360	25,615	52,718	100,199	121,500	151,300
Oregon	10,165	13,957	16,347	23,758	30,917	48,132	63,324	83,332
Pennsylvania	59,357	76,178	107,141	150,729	230,648	325,153	394,186	490,337
Rhode Island	7,565	9,894	12,311	16,362	21,406	25,142	35,218	39,563
South Carolina	10,000	11,500	15,000	14,500	19,000	36,822	55,492	70,143
South Dakota	14,481	14,578	20,068	29,336	44,271	67,158	90,521	104,625
Tennessee	9,973	14,103	19,668	27,266	31,400	48,500	63,000	80,422
Texas	35,187	54,362	64,732	90,000	197,687	213,334	251,118	263,392
Utah	2,576	4,021	6,139	7,994	13,507	21,226	32,273	35,144
Vermont	4,183	5,430	7,613	11,499	14,251	18,500	22,553	23,929
Virginia	5,760	9,022	13,985	21,357	35,426	55,661	72,228	95,000
Washington	13,990	24,178	30,253	36,905	62,546	93,822	117,278	168,146
West Virginia	5,349	5,088	7,217	13,256	20,437	31,306	38,750	50,203
Wisconsin	24,578	34,646	53,180	81,371	117,603	164,531	196,253	236,974
Wyoming	3,300	1,584	2,428	3,976	7,125	12,001	16,200	21,371
Total	1,009,513	1,253,034	1,754,570	2,423,788	3,544,952	4,941,276	6,146,617	7,523,664

*Compiled by Automotive Industries January 15, 1920.

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Number of Persons per Car December 31, 1919*

STATE	Population	Cars and Trucks	Population Per Car
Iowa	2,224,771	363,000	6.12
California	3,209,792	493,463	6.5446
Nebraska	1,309,627	200,100	6.5448
South Dakota	753,897	104,625	7.20
Kansas	1,896,520	228,601	8.25
Montana	499,816	58,117	8.60
District of Columbia	410,000	45,880	8.93
Minnesota	2,378,128	259,743	9.15
Wyoming	195,791	21,371	9.16
Arizona	280,280	28,979	9.66
North Dakota	817,554	82,886	9.86
Colorado	1,040,842	104,366	10.00
Washington	1,723,757	168,146	10.25
Indiana	2,872,842	277,255	10.35
Ohio	5,335,543	500,924	10.65
Michigan	3,173,089	296,378	10.70
Wisconsin	2,580,800	236,974	10.89
Oregon	914,493	83,332	10.97
Idaho	478,356	41,780	11.44
Connecticut	1,307,163	105,600	12.37
Nevada	118,745	9,305	12.76
Delaware	218,722	16,152	13.14
Utah	463,431	35,144	13.18
Illinois	6,400,473	478,438	13.38
Massachusetts	3,889,607	288,059	13.50
Maryland	1,395,405	98,995	14.19
New Hampshire	448,274	30,008	14.93
Missouri	3,467,401	229,577	15.10
Vermont	367,439	23,929	15.35
Maine	787,042	49,401	15.93
Oklahoma	2,465,402	151,300	16.29
Rhode Island	648,964	39,563	16.40
New Jersey	3,146,547	189,167	16.63
Florida	961,569	56,253	17.09
Texas	4,687,136	263,392	17.79
Pennsylvania	8,936,091	490,337	18.22
New York	10,833,795	555,789	19.49
New Mexico	450,381	20,000	22.51
North Carolina	2,497,668	109,000	22.91
Georgia	2,975,394	126,563	23.50
Virginia	2,255,036	95,000	23.73
South Carolina	1,678,664	70,143	23.93
Kentucky	2,423,001	90,008	26.91
Tennessee	2,337,879	80,422	29.07
West Virginia	1,465,729	50,203	29.19
Arkansas	1,819,587	49,488	36.79
Louisiana	1,912,603	50,000	38.25
Alabama	2,426,602	58,898	41.20
Mississippi	2,026,361	45,030	45.00
United States	106,877,895	7,523,664	14.20

*Compiled by Automotive Industries January 15, 1920.

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Production of and Value of Road Materials in the United States, 1918*

	Quantity	Value
Cement, barrels	70,915,508	$113,153,513
Paving sand, short tons	2,722,144	1,460,325
Gravel, short tons	20,640,101	11,791,073
Paving blocks, stone blocks	28,516,910	1,714,011
Paving brick, bricks	402,816,000	7,145,359
Crushed stone for road metal, short tons	9,696,447	9,369,671
Crushed stone for concrete, short tons	12,407,180	13,011,073
All crushed stone, short tons	29,373,342	27,951,393
Total value		$185,596,418

Production of Paving Sand and Gravel in the United States in 1918*

STATE	PAVING SAND		GRAVEL	
	Quantity (Short Tons)	Value	Quantity (Short Tons)	Value
Alabama	(a)	(a)	149,278	$ 122,953
Arizona	(a)	(a)		
Arkansas	(a)	(a)	18,513	21,192
California	457,255	$134,724	1,431,647	589,766
Colorado	(a)	(a)	65,412	50,056
Connecticut	(a)	(a)	(a)	(a)
Delaware	13,440	8,839	(a)	(a)
Florida	(a)	(a)	(a)	(a)
Georgia	(a)	(a)	18,500	19,900
Hawaii				
Idaho			(a)	(a)
Illinois	54,925	39,937	1,641,820	
Indiana	195,344	62,091	1,553,351	770,23
Iowa	62,577	30,202	524,541	361,20
Kansas	(a)	(a)	(a)	(a)
Kentucky			284,261	203,188
Louisiana	(a)	(a)	788,068	493,776
Maine			21,051	23,320
Maryland	(a)	(a)	876,964	768,182
Massachusetts	54,263	24,665	346,661	455,830
Michigan	237,317	89,430	1,741,681	872,23
Minnesota	5,350	4,700	355,851	232,097
Mississippi			392,689	190,686
Missouri			439,281	138,562
Montana			12,140	14,616
Nebraska	50,587	16,537	77,777	46,569
Nevada			(a)	(a)
New Hampshire	2,468	749	117,834	14,849
New Jersey	180,280	104,976	880,746	493,720
New Mexico			(a)	(a)
New York	131,276	77,170	1,386,092	673,448
North Carolina	(a)	(a)	250,418	128,415
North Dakota			(a)	(a)
Ohio	326,281	183,565	1,533,809	1,026,146
Oklahoma			85,276	39,745
Oregon	1,598	1,074	297,151	113,954
Pennsylvania	348,039	406,932	1,772,840	1,538,487
Rhode Island			(a)	(a)
South Carolina	(a)	(a)	4,627	3,016
South Dakota	3,769	1,982	34,353	21,537
Tennessee	(a)	(a)	377,425	246,299
Texas	(a)	(a)	568,705	288,679
Utah	(a)	(a)	98,480	61,063
Vermont	(a)	(a)	726	280
Virginia	(a)	(a)	389,635	276,312
Washington	251,292	96,716	434,428	177,932
West Virginia	40,222	29,824	124,309	117,811
Wisconsin	121,142	56,738	1,000,961	361,967
Wyoming			495,976	48,888
Combined totals	136,270	63,908	46,824	42,499
*Included in combined totals	2,673,695	$1,434,759	20,640,101	$11,793,993

*As compiled by the United States Geological Survey.

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Portland Cement Produced in the United States in 1917 and 1918, by States

U. S. Geological Survey Press Bulletin

STATE	PRODUCTION			PRICE	
	1917 (Barrels)	1918 (Barrels)	Percentage of Change, 1918	Average Factory Price Per Barrel, 1918	Percentage of Change, 1918
California:					
Shipments	5,659,547	4,238,424	— 25.1	$1.673	+27.5
Production	5,653,362	4,354,074	— 23.0	.....	.....
Stock	463,256	528,026	+ 14.0	.....	.....
Illinois:					
Shipments	4,378,233	3,703,471	— 15.4	1.538	+10.6
Production	4,659,990	3,594,038	— 22.9	.....	.....
Stock	739,763	646,255	— 12.6	.....	.....
Indiana:					
Shipments	8,148,678	6,205,326	— 23.8	1.544	+13.5
Production	8,705,831	5,291,851	— 39.2	.....	.....
Stock	1,760,532	822,888	— 53.3	.....	.....
Iowa:					
Shipments	4,428,765	3,188,669	— 28.0	1.701	+ 9.7
Production	4,626,141	3,626,455	— 21.6	.....	.....
Stock	618,811	1,055,340	+ 70.6	.....	.....
Kansas:					
Shipments	3,772,884	2,586,834	— 31.4	1.631	+16.8
Production	4,015,169	2,499,723	— 37.7	.....	.....
Stock	409,393	326,273	— 20.3	.....	.....
Michigan:					
Shipments	4,313,771	3,618,088	— 16.1	1.680	+18.4
Production	4,688,899	3,554,872	— 24.2	.....	.....
Stock	701,919	635,447	— 9.3	.....	.....
Missouri:					
Shipments	5,800,988	4,515,695	— 22.2	1.579	+11.0
Production	5,882,240	4,738,596	— 19.4	.....	.....
Stock	404,624	676,552	+ 67.2	.....	.....
New York:					
Shipments	5,408,726	4,074,159	— 24.7	1.612	+23.6
Production	5,417,530	4,095,588	— 24.4	.....	.....
Stock	804,811	832,271	+ 3.4	.....	.....
Ohio:					
Shipments	1,565,394	1,289,887	— 17.6	1.712	+15.1
Production	1,566,209	1,440,859	— 8.0	.....	.....
Stock	126,239	262,142	+107.7	.....	.....
Oklahoma:					
Shipments	1,736,761	1,218,841	— 29.8	1.807	+19.2
Production	1,772,466	1,246,515	— 29.7	.....	.....
Stock	70,708	89,188	+ 26.1	.....	.....
Pennsylvania:					
Shipments	27,709,442	22,238,689	— 19.7	1.511	+21.3
Production	27,752,838	22,628,901	— 18.5	.....	.....
Stock	2,455,588	2,840,810	+ 15.7	.....	.....
Texas:					
Shipments	2,358,944	1,918,919	— 18.7	1.719	+10.8
Production	2,436,398	1,971,867	— 19.1	.....	.....
Stock	222,537	289,779	+ 30.2	.....	.....
Utah:					
Shipments	899,599	549,593	— 38.9	1.680	+ 3.4
Production	929,730	570,310	— 38.7	.....	.....
Stock	106,580	133,465	+ 25.2	.....	.....
Washington:					
Shipments	1,403,191	1,116,754	— 20.4	1.894	+12.3
Production	1,513,792	931,489	— 38.5	.....	.....
Stock	385,707	214,220	— 44.5	.....	.....
Other States:*					
Shipments	13,118,551	10,452,159	— 20.3	1.628	+21.0
Production	13,193,607	10,536,525	— 20.1	.....	.....
Stock	1,083,370	1,101,094	+ 1.6	.....	.....
Total:					
Shipments	90,703,474	70,915,508	— 21.8	$1.596	+17.9
Production	92,814,202	71,081,663	— 23.4	.....	.....
Stock	10,353,838	10,453,950	+ 1.0	.....	.....

*1917: Alabama, Colorado, Georgia, Kentucky, Maryland, Minnesota, Montana, Nebraska, New Jersey, Oregon, Tennessee, Virginia and West Virginia. 1918: Nebraska omitted.

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Production of Vitrified Paving Brick and Granite Paving Blocks in the United States, 1918

From *"Mineral Resources in the United States,"* 1919

	Vitrified Brick or Block		Granite Paving Blocks	
	Quantity (Thousands)	Value	Number Blocks	Value
Alabama	25,631	$ 416,463		
Alaska				
Arizona				
Arkansas	*	*		
California	*	*	101,375	$ 5,142
Colorado	601	9,874		
Connecticut and Rhode Island	*	*	Conn. only *	*
Delaware				
District of Columbia				
Florida				
Georgia	4,279	85,107	511,100	24,622
Hawaii				
Idaho and Nevada				
Illinois	83,832	1,390,149		
Indiana	20,229	385,625		
Iowa	6,793	116,522		
Kansas	21,935	364,587		
Kentucky	*	*		
Louisiana				
Maine	*	*	6,573,847	432,075
Maryland	*	*	*	*
Massachusetts			4,523,302	284,634
Michigan	*	*		
Minnesota			195,334	14,975
Mississippi				
Missouri	*	*	236,000	16,435
Montana				
Nebraska	*	*		
New Hampshire			3,980,651	213,688
New Jersey				
New Mexico	*	*		
New York	5,265	113,395	1,432,018	75,844
North Carolina			2,265,206	119,188
North Dakota				
Ohio	105,165	1,809,355		
Oklahoma	8,458	151,283		
Oregon	*	*		
Pennsylvania	57,452	1,058,689	*	*
Porto Rico				
Rhode Island			*	*
South Carolina			*	*
South Dakota				
Tennessee	*	*		
Texas	*	*		
Utah				
Vermont			*	*
Virginia			232,000	11,223
Washington	*	*		
West Virginia	16,029	393,140		
Wisconsin			3,491,040	211,187
Wyoming				
Undistributed	47,146	851,170	2,381,653	138,599
Total	†402,816	†$7,145,359	25,923,526	$1,547,612

*Included in undistributed.

†In the total quantity and total value of vitrified brick are included respectively 297,730,000 vitrified brick or block sold for paving valued at $5,656,980 and 105,086,000 vitrified brick or block sold for other purposes valued at $1,488,379.

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Production and Value of Crushed Stone, 1918

From *"Mineral Resources in the United States,"* 1919

STATES	For Road Metal		For Concrete	
	Quantity Short Tons	Value	Quantity Short Tons	Value
Alabama	*	*	21,749	$ 23,548
Arizona	.....	.....	*	*
Arkansas	169,470	$191,743	69,939	97,668
California	747,185	483,949	1,219,709	886,331
Colorado	.....	.....	*	*
Connecticut	337,900	321,591	451,933	431,534
Delaware	*	*	*	*
District of Columbia	*	*	*	*
Florida	19,646	16,356	*	*
Georgia	40,635	78,158	158,294	237,950
Hawaii	63,273	75,257	97,753	140,836
Idaho	*	*	*	*
Illinois	748,592	489,360	1,335,978	964,140
Indiana	498,901	397,964	145,889	109,304
Iowa	*	*	211,404	192,869
Kansas	15,447	15,361	278,379	279,467
Kentucky	315,573	355,814	78,627	73,744
Louisiana	.....	.....	*	*
Maine	*	*	14,886	17,983
Maryland	148,972	233,961	267,447	382,366
Massachusetts	507,730	687,126	394,313	605,065
Michigan	*	*	392,865	266,837
Minnesota	*	*	293,220	369,449
Mississippi	.....	.....	.....	.....
Missouri	170,876	199,601	319,044	356,582
Montana	20,486	18,465	*	*
Nebraska	*	*	180,802	218,771
Nevada	.....	.....	*	*
New Hampshire	*	*	381,287	582,902
New Jersey	442,378	629,654	*	*
New Mexico	.....	.....	1,170,761	1,656,900
New York	899,836	893,271	451,359	644,839
North Carolina	36,270	55,518	.....	.....
North Dakota	.....	.....	.....	.....
Ohio	1,641,373	1,363,703	1,214,199	872,466
Oklahoma	22,097	24,483	223,947	219,194
Oregon	62,056	62,701	80,073	77,969
Pennsylvania	717,813	944,654	900,198	1,121,632
Rhode Island	45,140	68,406	3,500	5,150
South Carolina	*	*	*	*
South Dakota	*	*	12,145	13,469
Tennessee	309,041	243,774	308,051	265,291
Texas	154,642	120,330	340,661	288,328
Utah	*	*	*	*
Vermont	2,625	3,997	13,285	22,425
Virginia	202,251	248,012	372,684	409,393
Washington	*	*	26,969	23,779
West Virginia	113,962	154,670	82,032	102,332
Wisconsin	295,771	290,628	517,425	479,500
Wyoming	.....	.....	*	*
Undistributed	946,506	701,164	376,373	571,060
Total	9,696,447	$9,369,671	12,407,180	$13,011,073

*Included in undistribted.

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Cubic yards of loose gravel required to make one mile of road of different widths and thickness. Based on table of Department of Public Roads of New Jersey.

Width	Thickness of Road After Consolidation, Inches						
	6	7	8	9	10	11	12
Feet							
6	880	1,027	1,173	1,320	1,467	1,613	1,760
7	1,027	1,198	1,369	1,540	1,711	1,882	2,054
8	1,173	1,369	1,564	1,760	1,956	2,151	2,346
9	1,320	1,540	1,760	1,980	2,200	2,420	2,640
10	1,467	1,711	1,956	2,200	2,444	2,689	2,934
11	1,613	1,882	2,151	2,420	2,689	2,958	3,226
12	1,760	2,053	2,346	2,640	2,933	3,227	3,520
13	1,807	2,224	2,542	2,860	3,178	3,496	3,614
14	2,054	2,396	2,738	3,080	2,422	3,764	4,108
15	2,200	2,567	2,933	3,300	3,667	4,033	4,400
16	2,346	2,738	3,128	3,520	3,912	4,302	4,692
17	2,493	2,909	3,324	3,740	4,156	4,571	4,986
18	2,640	3,080	3,520	3,960	4,400	4,840	5,280
19	2,787	3,250	3,716	4,180	4,644	5,109	5,574
20	2,933	3,422	3,912	4,400	4,888	5,378	5,866

Length of road in linear feet which a load of stone of given size will cover to the given loose depths. Based on table of Wisconsin Highway Commission.

Width of Road	Loose Depth	Size of Load in Cubic Yards								
		1	1¼	1½	1¾	2	2¼	2½	2¾	3
Feet	Inches	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet
8	3	13.5	16.9	20.2	23.6	27.0	30.4	33.7	37.1	40.5
	4	10.1	12.6	15.2	17.7	20.2	22.6	25.3	27.8	30.3
	5	8.1	10.1	12.1	14.1	16.2	18.2	20.2	22.3	24.3
	6	6.75	8.4	10.1	11.8	13.5	15.2	16.9	18.5	20.3
9	3	12	15	18	21	24	27	30	33	36
	4	9	11.25	13.5	15.75	18	20.25	22.5	24.75	27
	5	7.2	9	10.8	12.6	14.4	16.2	18	19.8	21.6
	6	6	7.5	9	10.5	12	13.5	15	16.5	18
10	3	10.8	13.5	16.2	18.9	21.6	24.3	27	29.7	32.4
	4	8.1	10.1	12.2	14.2	16.2	18.2	20.2	22.3	24.2
	5	6.5	8.1	9.7	11.3	13.0	14.6	16.2	17.8	19.4
	6	5.4	6.7	8.1	9.4	10.8	12.1	13.5	14.8	16.2
12	3	9	11.2	13.5	15.8	18.0	20.2	22.5	24.7	27.0
	4	6.7	8.4	10.1	11.8	13.5	15.1	16.9	18.5	20.2
	5	5.4	6.7	8.1	9.4	10.6	12.1	13.5	14.8	16.2
	6	4.5	5.6	6.7	7.8	9	10.1	11.2	12.3	13.5

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Cubic yard of crushed stone or gravel required to give different depths when laying loose on one mile of roadways of different widths. Based on table of Wisconsin Highway Commission.

Width of Surface	Depth of Loose Material, Inches							
	1	1¼	1½	2	3	4	5	6
Feet	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
8	130	160	195	260	391	521	652	782
9	147	180	220	294	440	587	734	880
10	163	200	244	326	489	652	816	977
12	196	240	293	392	587	783	980	1,171
14	218	280	342	436	684	913	1,141	1,369
15	244	300	366	488	733	979	1,222	1,466
16	261	325	391	522	782	1,043	1,304	1,565
18	294	367	440	588	880	1,174	1,468	1,760
20	326	400	488	652	978	1,304	1,632	1,954
22	359	440	537	718	1,076	1,434	1,796	2,148
24	392	480	584	784	1,174	1,564	1,960	2,342

Weight in Pounds Per Cubic Yard of Sand and Gravel.

From *"Mineral Resources in the United States,"* 1919

State	Sand	Gravel	State	Sand	Gravel	State	Sand	Gravel
Alabama	2505	2790	Massachusetts	2710	2810	Oregon	2620	2880
California	2645	2895	Michigan	2895	2985	Pennsylvania	2500	2680
Florida	2605	2680	Minnesota	2865	2880	Texas	2695	2910
Illinois	2820	3005	Missouri	2680	2840	Washington	2930	3065
Indiana	2700	2945	New Jersey	2600	2730	W. Virginia	2570	2780
Iowa	2720	2850	New York	2590	2760	Wisconsin	2800	2970
Kentucky	2580	2830	Ohio	2700	2830	Average	2665	2820

Note.—The average weights were obtained from 670 producers of sand and 560 producers of gravel in all parts of the country; the range was from 2200 to 4000 pounds for sand and from 2200 to 4200 pounds for gravel. The weights given for each state are the averages of the reports from ten or more producers in that State.

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NAMES AND ADDRESSES OF CONTRACTORS REPORTED AS BIDDING ON HIGHWAY WORK DURING 1919

Names furnished by State Highway Department

Alabama

American Casting Co., Birmingham
Bradshaw, J. M., Box 742, Muscle Shoals
Brown & Sons, J. C., 116 Cramer Ave., Montgomery
Cook, D. R., Montgomery
Draper, G. A., Gorgas.
Gillis, J. N. & Son, Brewton
Goodrich Construction Co., Anniston
Hill, R. G. & Co., Birmingham
Inglis, B. A., Alton
McLeod, E. C., Kendrick
Newell Auto & Machinery Co., 2209 1st Ave., Birmingham
Newell Construction Co., Birmingham
Oliver Construction Co., Florence
Southern Bridge Co., Birmingham
Stanley & Singer, LaFayette
Thomas, Wm. Hyde, Montgomery

Arizona

California-Arizona Construction Co., O'Neil Bldg., Phoenix
Foundation Co., The Globe
Gillis Engineering & Contracting Co., Phoenix
Johnson, F. C., Phoenix
O'Brien & McGrath, Phoenix
Twohey Bros., Jerome

Arkansas

Arkansas Construction Co., Little Rock
Ball-Benton Gravel Co., 821 Southern Trust Co., Little Rock
Burke Construction Co., Ft. Smith
Cole, M. J., Little Rock
Cook, M. D. L., Little Rock
Edwards, J. E., Little Rock
Fields, Julian, Grady
Gregory & Gregory, Walnut Ridge
Gregory & Wilson, Newport
Hill & Co., Tom Pine Bluff
Inland Construction Co., Eureka Springs
Lewelling & Price-Williams, Forrest City, Little Rock
McGeorge, W. P. & Co., Pine Bluff
Mobley, R., Little Rock
Peay Construction Co., Nick, Little Rock
Perdue & Hensley, Pine Bluff
Philpot & Humphreys, Southern Trust Co., Little Rock
Ritchie, W. P., Camden
Shinn & Amermann, Wynne
Taylor, Ralph, Texarkana
Van Winkle Construction Co., Little Rock
White Construction Co., McGehee
Womack Construction Co., Texarkana
Woodsmall Construction Co., Little Rock
Young Construction Co., A. R., Little Rock

California

Arndt, Wm. B., Chronicle Bldg., San Francisco
Bates, Borland & Ayer, Oakland Bank of Savings Bldg., Oakland
Bechtel, Warren A., 1006 Merchants Natl. Bank Bldg., San Francisco
Benson, Geo. S. & Sons, 531 Stimson Bldg., Los Angeles
Blanchard-Brown Co., 100 Tara St., San Francisco
Blanchard, Crocker & Howell, 58 Second St., San Francisco
Blumenkranz, M., Stockton
Bordwell & Zimmerman, Calistoga
California Corrugated Culvert Co., West Berkeley
California Road & Street Impr. Co., 217 Holland Bldg., Fresno
City Street Improvement Co., 3001 17th Street, San Francisco
Clark & Henery Const. Co., Ochsner Bldg., Sacramento
Conner, J. L., Higgins Bldg., Los Angeles
Conners, Green & Co., Castella
Cotten, C. E., 16 California St., San Francisco
Crowley, Byron J., 2100 17th St., San Francisco
Curtis, Geo. R., 2440 E. 26th St., Los Angeles
Daley, Geo. R., 533 F St., Hill Block, Box 991, San Diego
deWaard Bros., Box 327, Redding
Dietzgen Co., Eugene, 118 1st St., San Francisco
Dontanville, W. A., Arroyo Grande
Duncanson-Harrelson Co., 1405 Chronicle Bldg., San Francisco
Eaton & Smith, 407 11th St., San Francisco
Engelhart, Thomas, P. O. Box 875, Eureka
Erickson & Petterson, Inc., Monadnock Bldg., San Francisco
Fairbanks, A. J., Auburn
Federal Construction Co., 620 Call Bldg., San Francisco
Figone, August, Willits
Fitzpatrick, J. F., Ochsner Bldg., Sacramento
Flynn & Tracey, 1st Natl. Bank Bldg., San Francisco
Francisco, H., Laws
Gavin, E. B., 204 Hugo St., San Francisco
Gildersleeve, C. H., Napa
Grier, Arthur J., 480 Chetwood St., Oakland
Grimwood, H. G., 248 W. 7th St., Los Angeles

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Gyles, Edw., 217 E. 8th St., Los Angeles
Hall, W. E., 5945 University Ave., East San Diego
Harding, Geo. W., 737 Hellman Bldg., San Francisco
Haviland & Tibbetts, Alaska Commercial Bldg., San Francisco
Healy-Tibbitts Construction Co., Market & Main Sts., San Francisco
Hendricks, W. N., 126 S. Fremont St., Los Angeles
Hoare, P. H., Room 4, Bacon Bldg., Oakland
Hoffman, Fred, 111 E. 12th St., Long Beach
Holland, J. P., 540 Brannon St., San Francisco
Hudson, C. H., 408 March-Strong Bldg., Los Angeles
Humboldt Dredging Co., 530 2nd St., Eureka
Hunter, J. P. & R. A. Wattson, 405 W. 58th St., Los Angeles
Isbell Construction Co., Box 897, Bakersfield
Johnson-Shea Co., Inc., 202 Central Bldg., Oakland
Johnston, Jas. E., Tracy
Kier Construction Co., W. E., 813 American Bldg., San Diego
Laiblin, C. H., Manteca
Ledbetter, W. M., & Co., 651 Pacific Elec. Bldg., Los Angeles
Lindley, Curtis, Jr., Concord, Contra Costa Co.
Macrae & Layaz, 1331 California St., San Francisco
Mahoney Bros., Hobart Bldg., San Francisco
Malley, Edw., New Call Bldg., San Francisco
Markel, R. B., 956 Clayton St., San Francisco
Marshall, John A., 2967 Avalon Ave., Berkeley
May, John H., 204 G St., Napa
McCrae, A. L. & Geo. H. Oswald, 422 American Bank Bldg., Los Angeles
McIntire, Frank G., 406 Farmers & Mechanics Bank Bldg., Los Angeles
Mercer-Fraser Co., Eureka
Moffett, J. P., 491 Monadnock Bldg., San Francisco
Moore Co., F. F., 328 Milpas Blvd., Santa Barbara
Municipal Improvement Co., Everson Bldg., 357 12th St., Oakland
Nelson, Olaf, 1470 E Street, San Diego
Newsom, W. A., 221 Sharon Bldg., San Francisco
Palmer & McBryde, Cunard Bldg., San Francisco
Price, W. E., 218 Bocana St., San Francisco
Raisch Improvement Co., 510 Underwood Bldg., San Francisco
Reilly, P. F., 180 Jessie St., San Francisco
Ritchie, O. G., 319 Chronicle Bldg., San Francisco
Rogers Bros. Co., 350 Merrick St., Los Angeles
Rolandi, F., Bank of Italy Bldg., San Francisco
Ronsome-Crummy Co., 28th & Poplar Sts., Oakland
Rooney, Jas. H., Merchants Natl. Bank Bldg., Santa Monica
Ross Construction Co., Forum Bldg., Sacramento
Ryan, David H., 3606 Sierra St., East San Diego
Ryan & Son, Maurice, Alpine
Schmidt, W. J. & E., 2027 Shattuck Ave., Berkeley
Shattuck-Eddinger Co., 307 Underwood Bldg., San Francisco
Sherer & Co., Robert, 548 Pacific Elec. Bldg., Los Angeles
Sinai, J. J., care Mrs. John Dougerty, Lodi
Soteras, Chas. D., 801 Black Bldg., Los Angeles
Thompson Bros., 1514 H Street, Fresno
Tibbitts Pacific Co., 16 California St., San Francisco
Tieslau Bros., 2814 Grove St., Berkeley
Treacy, Edmund J., 1st Natl. Bank Bldg., San Francisco
Tuttle Co., Geo. W., 311 Wright & Callender Bldg., Los Angeles
Vogt, Alfred H., 411 Sharon Bldg., San Francisco
Western Contracting Co., 351 Noe St., San Francisco
Western Labor Bureau Co., 130½ J St., Sacramento
White & Gaskill, Long Beach
Worswick St. Paving Co., Union Natl. Bank Bldg., Fresno

Colorado

Baker, Chas., Walden
Levy Construction Co., 630 Synes Bldg., Denver
Monarch Engineering Co., Denver
Moore, H. W. & Co., 1750-61 Wazee St., Denver
Roberts Construction Co., Fred, 312 Tramway Bldg., Denver

Connecticut

Acme Engineering Co., 868 Main St., Hartford
Arborio, John 36 Ward St., New Haven
Arrigoni & Bros., Frank, 605 Main St., Middletown
Arthur, W. H., Washington Bldg., Stamford
Balf Co., The Edw., 26 State St., Hartford.
Barbara, Jos., 90 Franklin St., Waterbury
Benvenuti & Sons, N., 74 Goshen St., New London
Berlin Construction Co., Berlin
Blakeslee & Sons, C. W., 58 Waverly St., New Haven
Brazos & Sons, A., 66 Oak St., Middletown
Brazos, Frank, 808 Elm St., New Haven
Bridges' Sons, A. D., Hazardville
Bruch, Lawrence, North Haven
Chiapetta, Jos., Greenwich
Clark, E. N., Cherry St., Milford

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Conn. Hassam Paving Co., 902 Chapel St., New Haven
Conn. & R. I. Co., Meriden
Crowley, Daniel F., Bristol
Curtiss & Dean, 253 Asylum St., Hartford
Daley Co., R. D., 6 Church St., New Haven
Deane & Coe, Plainville
DeMichiel & Bro., John, 58 High St., Torrington
Donahue Bros., 127 Grand St., Middletown
Eastern Eng. & Constr. Co., Main & Eliz. Sts., Derby
Fabbri, Frank, Litchfield.
Foley, T. F., 23 Quintard Ave., So. Norwalk
Gilbert, F. H., Jewett City
Gilbert, John A., 17 Spring St., Danielson
Gilbert Wm. T., 302 Prospect St., Torrington
Grozier & Co., J. H., 721 Main St., Hartford
Hastings, F. B., 2450 North Ave., Bridgeport
Herbert, A. W., East Canaan
Immich Co., Meriden
Kearney, Richard T., Meriden
Lane Construction Co., 35 Colony St., Meriden
Lathrop & Shea, 185 Church St., New Haven
Lees, Wm. M., Sperry Eng. Co., New Haven
Levering & Garriques, 35 Pearl St., Hartford
Longhi & Bro., Louis, Torrington
Maguire, John P., 580 Arch St., New Britain
Maher-Sprague, Chamber of Commerce Bldg., New Haven
Marola, Ernest, 380 Litchfield St., Torrington
Mascetti & Holley, 561 S. Main St., Torrington
Miller, Fred D., RFD 6, Norwich
Mitchell, J. L., South Britain
Nichols, Wm. A., Bridgeport
O'Donnell Co., The 87 High St., Hartford
Osborn-Barnes Co., 20 West St., Danbury
Ossola & Besozzi Co., 164 Pythian Ave., Torrington
Robinson, Calvin C., 422 Front Ave., West Haven
Ryan, Sam T., 145 Barker St., Hartford
Scott Co., T. A., New London
Shay, M. P., New London
Sibley, Chas. A., 902 Chapel St., New Haven
Suzio Construction Co., L. Meriden
Sweeney, P. F., Fitchville
Toole & Sunderlin, Warner Bldg., Bridgeport
Toomey, Daniel F., Norwalk
Tracy, Edw., Derby
Valerio, Francesco, 117 Wheeler Ave., Bridgeport
Valli, Giedo, 74 Oak Ave., Harwinton
Vito Construction Co., A., Thompson
Weller, Frank H., Stratford
Wilcox, W. B., Norwich
Wooster, C. B., Ansonia

Delaware

Cohen, Frank L., Smyrna
DuPont Co., The, Wilmington.
DuPont, de Mennours & Co., E. I., Wilmington
Elder D. D., 1308 Tatnall St., Wilmington
Heyman & Goodman Co., Dover
Walker, Harford P., Laurel

District of Columbia

Castigan, Edw., Washington
Cranford Paving Co., Washington
Cush, Wm. F., Washington
Hampton Construction Co., Union Savings Bank Bldg., Washington
Hyman, Geo., Washington
Mullin, G. B., Washington
Palmer, H. T. (contractor) 27th & K St., N. W., Washington
Road Contractor Service, 600 F St., N. W., Washington
Weller Construction Co., Washington

Florida

Barnes Construction Co., Lecanto
Converse Bridge & Steel Co., Leesburg
Dawkins Construction Co., C. T. Box 958, Jacksonville
Donahoo, J. D., Box 1753, Jacksonville.
Edwards, J. G., Jacksonville
Hadlow, W. T., Jacksonville
Kennedy, W. P., Quincy
Logan Bros., Arcadia
Long, Fred W., East Bay St., Jacksonville
Peninsular Engineering Co., St. Cloud
Perkins, C. W., 1444 Market St., Jacksonville
Ploof, H. F., S. Jacksonville
Richardson, W. P., Duval Bldg., Jacksonville
Steadham & Hughes, Lakeland
Thomas, W. H., Greenville
Wilson Construction Co., Jacksonville

Georgia

Akin, M. C., Decatur
Atlantic Bit Co.
Austin Bros., Atlanta
Austin-Western Road Machinery Co., Box 1203, Atlanta
Crawford, Wm., Camp Hancock, Wrightsboro Rd., Augusta
Crump Construction Co., A. B., Macon
Finley Method (Sam Finley), Candler Bldg., Atlanta
Gardner & Doughtie, Columbus
Georgia Engineering Co., Augusta
Hardaway Construction Co., Columbus
Harrington, G. M., care Georgia Tech., Atlanta
Hudson Co., R. M., Healy Bldg., Atlanta
Lawrence Construction Co., Augusta
Maddox, J. W. (contractor), Atlanta
Morgan, E., Savannah
Nichols Construction Co., Atlanta
Ramsey & Co., R. M., Tocoa
Smith Construction Co., Forsyth Bldg., Atlanta

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Williams, W. Z., Macon

Idaho

Boomer, H. H., Salmon
Carroll & Salmon, Burley
Carscallen Bros., Cour d'Alene
Comerford, S. C., Boise
Cornell, H. E., Sherman House, Boise
Hoskins & Co., J. A., Grangeville
Idaho Construction Co., Boise
Knottenbelt, J., Idaho Falls
Maney Bros., Boise
Missouri Valley Bridge & Iron Co., McCarthy Bldg., Boise
Morrison-Knudson Co., Boise
Security Bridge Co., Lewiston
Smith & Green, Mackay

Illinois

American Contractor Publ. Co., 6 N. Michigan Ave., Chicago
American Steel & Wire Co., 208 LaSalle St., Chicago
American System of Reinforcing 10 S. LaSalle St., Chicago
Austin-Western Road Machinery Co., Room 904 Karpen Bldg., Chicago
Barber Asphalt Paving Co., 1328 Tribune Bldg., Chicago
Bates & Rogers Construction Co., 37 W. Van Buren St., Chicago
Brogan, John, Eldred.
Brownell Improvement Co., 1220 Chamber of Commerce Bldg., Chicago
Calumet Construction Co., 100 W. 15th St., Chicago
Carson Petroleum Co., 208 S. LaSalle St., Chicago
Chicago Hts. Coal Co., Chicago Hts.
Connors, J. J., 1246 Melrose St., Chicago
Contracting & Material Co., 10 S. LaSalle St., Chicago
Dodge Co., F. W., Monadnock Blk., Chicago
Dunlap & Dippold, Edwardsville
East St. Louis Bridge Co., East St. Louis
Embankment Co., Chicago
Federal Bridge & Structural Co., Chicago
Federal Paving Co., 133 W. Wash. Ave., Chicago
Federal Petroleum Co. 116 S. Michigan Ave., Chicago
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Hart & Page, Rockford
Heaps, C. E., Moline
Hayworth, J. O., Chicago
Highway Engineer & Contractor, 542 Monadnock Blk., Chicago
Holden, E., 538 S. Clark St., Chicago
Holmes, Harry C., Macomb
Illinois Bridge Co., 1629 Monadnock Blk., Chicago
Illinois Hydraulic Stone & Constr. Co., Elgin
Illinois Steel Co., Warehouse Dept., Chicago
Intra State Construction Co., 79 W. Monroe St., Chicago
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Joliet Construction Co., Joliet
Koontz, Kenneth, 5088 Sunnyside Ave., Chicago
Lehigh Portland Cement Co., Conway Bldg., Chicago
Liljequist, L. A., Freeport
Loomis Co., A. C., Mattoon
Lord Construction Co., E. A., Monmouth
Louvenberg & Louvenberg, 1032 Natl. Life Bldg., Chicago
Lowry, R. M., 122 S. Michigan Ave., Chicago
McCaughey Bros., (F. P. & P. E.) 6412 Glenwood Ave., Chicago
McCaughey Co., J. J. Security Bldg., Chicago
McCaughey, T. J., 3402 Magnolia Ave., Chicago
McCoy, A. O., Versailles
Mekemson Bros., Hamilton
Midco Oil Sales Co., Conway Bldg., Chicago
Municipal Equipment & Construction Co., Chicago
Parham Construction Co., 3029 Waverly Ave., E. St., Louis
Parish, Alan J., Paris
Pioneer Asphalt Co., Lawrenceville
Powers-Thompson, Constr. Co., Joliet
Roxana Petroleum Co., 208 S. LaSalle St., Chicago
Ruthledge, A. E., Rockford
Sarco Petroleum Products Co., Chicago
Shans, W. H., Freeport
Sherman, M. A., 905 N. Campbell Ave., Chicago
Sleeter, J. R., Metropolis
Standish & Allen, 1420 Consumers Bldg., Chicago
Stipes & Pilcher, Springfield
Thomas Construction Co., Chicago
Thompson, C. A., 10th & 26th Sts., Rock Island
Trowbridge, E. C., Springfield
Union Products Co., Drawer "H", East Chicago
Universal Portland Cement Co., 210 S. LaSalle St., Chicago
Ward & Son, Andrew, Oak Glen
Whitlock, Thos., Exeter
Williston Construction Co., 343 S. Dearborn St., Chicago
Woods, O. H., 137 S. LaSalle St., Chicago
Yale & Reagan, Conway Bldg., Chicago

Indiana

Adams Grader Co., Indianapolis
Ajax Construction Co., Gary
Berns, Ernest, 601 Lombard Bldg., Indianapolis
Brooks Construction Co., Ft. Wayne
Brown, Chas. C., Municipal Engr. Magazine, Indianapolis
Burke Bros. Construction Co., 30 W. 9th St., Anderson
Burke Construction Co., The New Castle
Bushnall Patton Co., 301 Munger Bldg., Elkhart

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Cross, Ben F., LaPorte
Cross, Geo. M., LaPorte
Culbertson & Culberston, Richmond
Cunningham, Fred, Martinville
Downey & Ports, Hammond
Feulling & Kundof, Ft. Wayne
Foster & Son, H. C., Richmond
Gary Construction Co., Gary
Good Roads Machinery Co., Ft. Wayne
Greenberg Iron Co., Terre Haute
Greenwald, Neydhl, Hammond
Hackendorn Contracting Co., 1134 Indiana Pythian Bldg., Indianapolis
Hatch & Sons, W. W., Goshen
Highway Iron Products Co., Ligonier
Hipskind, John, Richmond
Hodson-David Constr. Co., Gary
Indiana Asphalt Paving Co., Indianapolis
International Steel & Iron Co., Evansville
Levine, Thos., Hammond
Municipal Contracting & Supply Co., Gary
Municipal Engineering, Indianapolis
National Concrete Co., Indianapolis
Premier Construction Co., Indianapolis
Redington, C. E., Greensburg
Rieth Constructing Co., Goshen
Rochester Bridge Co., Rochester
Smith, I. E., Richmond
Smith & Co., W. F., Renssalaer
Sparks, Thos., Aetna Green
Sprinkle & Frost, Portland
Tapp Construction Co., Herman, Ft. Wayne
Teach, Frank, Crown Point
Trippeer & Son, Peru
United Paving & Construction Co., Indianapolis
Vincennes Bridge Co., Vincennes

Iowa

Aiken & Flutter, Des Moines
Balzer, F. F., Des Moines
Barnes Bros., Des Moines
Betz Bros., Sioux City
Blythe Bros., Tama
Bowers, Sam, Ames
Bryant Paving Co., Waterloo
Burlington Construction Co., Burlington
Cameron-Joyce Co., 178 7th St., Keokuk
Carey & Son, Thos., Clinton
Carouff, W. L., Marshalltown
Carter, W. B., Sioux City
Christi, W. E., 1708 Logan Ave., Des Moines
Cox, Allen, Perry
Davenport Locomotive Works, Davenport
Dearborn Construction Co., Waterloo
Des Moines Asphalt Paving Co., Des Moines
Desparios, F. R., Des Moines
Dunnegan, J. J., Shenandoah
Dutton, Wm., Boone
Elzy, R. F., Marshalltown
Ellrick, Raymond, Newell
Empire Construction Co., Des Moines
Flynn Paving Co., M. L., Sioux City
Ford Paving Co., Cedar Rapids
Fort Dodge Culvert Co., Sioux City
Fuller Bros., Muscatine
Geary & Thomas, Marathon
Gould Construction Co., Davenport
Grinnell, W. K., 2150 Ingersoll Ave., Des Moines
Hanlon & Oakes, Sioux City
Herbert, John, Jr., Marshalltown
Hook, Wm., Auburn
Horribin & Co., Jas., Des Moines
Hoy, J. E., Vail
Joyce, P. J., New Albin
Keeler Co., D. E., Davenport
Kughn & Sons, J. E., Dows
Leach Bros., Washta
Litting Construction Co., Davenport
McAndrew, J. E., Madrid
McCarthy Improvement Co., Davenport
McCurdy, A. B., Dedham
McLaughlin & Sons, J. S., Red Oak
Maddy, Clint, Oskaloosa
Mason City Fuel & Const. Co., Mason City
Matthes Coal Co., 180 Bowditch St., Davenport
Miller, J. H., Rt. No. 2, Manning
Miller Engineering Co., Lemars
Mills Construction Co., Logan
Moore-Seig Construction Co., Waterloo
Moran, M., Moville
Northwestern States Portland Cement Co., Mason City
Parquette, J. C., 2347 Capital Ave., Des Moines
Reinking Construction Co., Des Moines
Reynolds, Jas., Sioux City
Richardson, Frank, Elwell
Ryan Construction Co., D. J., Davenport
Ryan, P. J., 227 Fairview, Council Bluffs
Ryan, Tim, Missouri Valley
Sawyer, E. E., Clear Lake
Shipman, W. R., 2101 Lakeport, Sioux City
Shugart, P. E., Nevada
Smith, Hans, Linn Grove
Snater Construction Co., Ackely
Teepeel, Adam, Lakeview
Turner Improvement Co., Des Moines
Wagner Co., The, Des Moines
Ward Construction Co., Decorah
Waugh Construction Co., Clarksville
Western Asphalt, Paving Corp., Sioux City
White, H. G., Clarion
Wickham Co., E. A., Council Bluffs
Wilson, E. J., 508 E. Pierce St., Council Bluffs
Wisely & Son, Forest City
Witmer Co., The, 521 CNB. Bldg., Des Moines
Wood & Co., L. C., Alden
Wright Construction Co., Alden
Zwack, Anton, Dubuque

Kansas

Allen & Fulton, 1337 Lane St., Topeka
Amerman, M. R., Salina
Boroughs, Paul Kingman
Conner, Fred C., 121 N., Market St., Wichita
Construction News, The, 308 Central Bank Bldg., Topeka

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Dunn & Co., D. E., Wichita
Elliott & Vance, Parsons
Fulton, W. S., 1907 Buchanan, Topeka
Glidden-Hobbs, 901 Michigan, Lawrence
Gustafson-Forsberg, Leonardville
Jackson-Walker Coal & Mining Co., 142 Lawrence, Wichita
Kaw Paving Co., 616 N. E. Bldg., Topeka
Kelleher, L. M., Burlingame
Kepler, H. A., 700 W. 12th St., Kansas City
Leavenworth Bridge Co., Leavenworth
Missouri Valley Bridge Co., Leavenworth
Missouri Valley Bridge & Iron Co., 1006 Schweiter Bldg., Wichita
Newell & Son, J. H., 730 Chestnut St., Topeka
Opfer, H. W., Hanover
Road Supply & Metal Co., Topeka
Schermerhorn, V. E., Ogden
Scott, John R., Holyrood
Stamey-Construction Co., The, 316 2nd St., E. Hutchinson
Topeka Bridge & Iron Co., Topeka
Wayland, W. C., Washington
Western Bridge Co., Harrisonville
Wolf & Prose, Macksville
Young, A. R., Lawrence

Kentucky

Adams & Belote, Mayfield
Ader, Frank G., Newport
Bell Construction Co., 372 Transylvania Park, Lexington
Bickel Co., Henry, Louisville
Bickle Asphalt Paving Co., Louisville
Blandford, T. O. Agt. Galion Works, 1567 Bardstown Road, Louisville
Bluegrass Construction Co., The, Bardstown
Boggs, Joe S., Richmond
Breslin, F. G., Ky. Asphalto Road Co., 2615 Crop St., Louisville
Byers Operating & Construction Co., Adairville
Cain & Woods, Paris
Carey Reed Co., Lexington
Chilton, E. A., London
Codell-Byers Construction Co., Winchester
Connelly Construction Co., Somerset
Eady Co., Geo. M., Inter Southern Bldg., Louisville
Eaton Oil Works, The Covington
Elliott & Redower, Maysville
Figg Co., L. R., Louisville
Gormley Bros., Versailles
Gorrell, F. G., Russellville
Gregg, G. R., 2606 Hale Ave., Louisville
Haggard, Brent, Winchester
Hancock, L. W., Louisville
Harris, C. E., Erlanger
Harris & Meyers, 213 W. 4th St., Covington
Hunt-Forbes Construction Co., Ashland
Kentucky Consumers Oil Co., Louisville
Kentucky Culvert & Mfg. Co., Louisville
Kentucky Rock Asphalt Co., Paul Jones Bldg., Louisville
King Construction Co., Frankfort
McClure Construction Co., Harrodsburg
McHenry, John J., 612 Columbia Bldg., Louisville
Miller Coal & Contract Co., Owensboro
Moynahan, E., P. O. Box 472, Nicholasville
Moynahan & Forbes, Richmond
Murphy Bros. Co., Bowling Green
Newport Culvert Co., Newport
Phares, Fred, Lexington
Phelps, Frank W., 432 Johnson Ave., Lexington
Phelps-Post Guyn Co., Lexington, Ky.
Ping Bros., Colo
Poindexter, J. R., Cynthiana
Power, C. O., care J. P. Speed Co., Louisville
Price, R. A., Bowling Green
Southern Asphaltoilene Road Co., 114 S. 4th St., Louisville
Standard Oil Co., Louisville.
Stebler, Alex, St. Mathews
Sutton Construction Co., Pikesville
Taylor & Son, Danville
Tipton, W. R., Mt. Sterling
Tyler Co., R. B., Louisville
Van Sant, Guy, Frankfort
Walker, Willie, 475 W. 2nd St., Lexington
Welbourne & Co., Starks Bldg., Louisville.
Wilmore Construction Co., Wilmore
Young, R. J., Jewell Tobacco House, Lexington

Louisiana

Abney, W. A., 2226 Seymore St., Shreveport
Acme Sand & Gravel Co., Hibernia Bldg., New Orleans
Alexandria Gravel Co., Alexandria
American Creosote Works, New Orleans
American Surety Co., of New York, 833 Gravier St., New Orleans
Bael, R. L., Box 285, Pineville
Baker, John, Jr., 608 Hibernia Bldg., New Orleans
Barbour, F. C., Shreveport
Barrett Mfg. Co., New Orleans
Black, J. L., P. O. Box 484, New Orleans
Black Co., Roger, 801 Hibernia Bank Bldg., New Orleans
Blackmore-Allen, 710 Hennen Bldg., New Orleans
Blodgett Construction Co., Shreveport
Blum & McNamara, New Orleans
Bodenheimer & Son, H., New Orleans
Bonner, W. S., 800 Audubon Bldg., New Orleans
Caddo Construction Co., 671 Stone Ave., Shreveport
Caddy Gravel Co., McNary
Colonial Creosoting Co., Bogalusa
Constant, F. T., P. O. Box 220, Alexandria
Cooper, Walter F., Killona
Craven & Lang, 603 Hibernia Bldg., New Orleans
Creosoted M. & I. Co., 301 "Q. & C." Bldg., New Orleans
Crossen, H. G., 127 S. Derbigny St., New Orleans
Dixie Culvert & Metal Co., New Orleans
Dunn & Co., F. C., 632 Gravier St., New Orleans.
Earl, Wm., Donaldsonville

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Fidelity & Deposit Co. of Maryland, New Orleans
Foster Creek Gravel Co., New Orleans
Gano, S. A., Maison Blanche Bldg, New Orleans
Garley, A. J., P. O. Box 185, Alexandria
George & Sons, J. N., Mansfield
Geren, W. E., Columbia
Grasser Contracting Co., 912 Hennen Bldg., New Orleans
Haase, J. A., 824 Gravier St., New Orleans
Harry Bros. Co. of Louisiana, New Orleans
Hercules Powder Sales Co., New Orleans
Highland Gravel Co., New Orleans
Hotard, Theo., 320 Opelousas Ave., Algiers
Huth Dredging Co., Franklin
Hyatt, E. C., 851 Magazine St., New Orleans
Irving, John, Bayou Sara
Jahncke Navigation Co., 814 Howard Ave., New Orleans
Lambert & Co., Ruston
Lambou, Victor, 645 Broad St., New Orleans
Leopold, Simon, Phoenix
Louisiana Creosoting Co., Winnfield
Louisiana Logging Co., Chestnut
Louisiana Sand, Gravel & Const. Co., West Monroe
McGinnis, Irwin, Alexandria
Minden Gravel Co., Minden
Montgomery, J. M., P. O. Box 611, Shreveport
Morgan Sand & Gravel Co., Sibley
New Oreans Roofing & Metal Co., New Orleans
Nodstrom, Chas., Alexandria
Perry, A. E., Crowley
Phillips, J. W., Winnfield
Preygang, Henry, DeSoto Hotel, New Orleans
Prutsman, G. W., 611 Common St., New Orleans
Purvis, J. G., 925 Louisiana, Lake Charles
Rapids Gravel Co., Alexandria
Robertson, Gano, care of W. N. Peterman, Marksville
Sawyer, L. P., P. O. Box 597, Shreveport
Shaughnessy, D. G., 702 Hennen Bldg., New Orleans
Shaw, D. C., Baton Rouge
Smith Bros., P. O. Box 518, Alexandria
Soileau & Webber, Abbeville
Southern Co., The, New Orleans
Southern Mineral, Land & Development Co., Winnfield
Standard Oil Co., New Orleans
Texas Oil Co., New Orleans
Thomas, A. G., 208 Hibernia Bldg., New Orleans
Thompson, J. W., Hennen Bldg, New Orleans
Tioga Gravel Co., Alexandria
U. S. Fidelity & Guaranty Co., Whitney Cen't. Bldg, New Orleans
Veal, C. H., 838 Common St., New Orleans
Villers, W. P., 3221 Grand Route, St. John, New Orleans
Warren Dredging Co., Lake Charles
Weber, H. B., Lafayette
Webster Sand & Gravel Co., Minden
Wilkinson, H. S., P. O. Box 491, Jennings
Womack, T. G., Kentwood

Maine

Fleming, John G., Lincoln
Forgione & Romano, Fidelity Bldg., Portland
Greenwood & Ford, Skowhegan
Hughes, M., 220 3d St., Bangor
Kerr, Jas. H., Rumford
McGregor, Jas., Rumford
Small & Ingalls, Bar Harbor
Smith & Havey, West Sullivan
Susi, D., Burnham

Maryland

Aetna Construction Co., Snow Hill
American Bridge Co., 600 Continental Trust Bldg., Baltimore
Andrews Construction Co., David M., 600 Equitable Bldg., Baltimore
Andrews, S. R., Elkton
Angle, W. H., Hagerstown
Austin-Bennett Construction Co., P. O. Box 356, Baltimore
Bennett, H. D., Baltimore
Bester-Long Co., Hagerstown
Brotemarkle, S. T., Cumberland
Brown, E., Lanham
Brown, E. Ward, Port Deposit
Cain, J. M., Baltimore
Carozza, F. D., Baltimore
Clairborne-Johnson & Co., 910 Garrett Bldg., Baltimore
Collins, R. G., Jr., Munsey Bldg., Baltimore
Consolidated Engineering Co., Baltimore
Cooksey, R. M., Baltimore
Cumberland Construction Co., Cumberland
Della, Thos. A., Hyattsville
England, H. L., Rockville
Farmer & Flick, Baltimore
Firor, H. O., Baltimore
Fisher & Carozza Bros. Co., 803 Calvert Bldg., Baltimore
Flanigan & Sons, P., Baltimore
Forsythe, Thos. C., 600 Equitable Bldg., Baltimore
Good Roads Co., The, 214 Keyser Bldg., Baltimore
Ireland, F. M., Baltimore
Holt Construction Co., Denton
Kaylor, H. W., Hagerstown
McAllister, D. C., Baltimore
McDowell, C. J., Port Deposit
Maryland Dredging Co., Baltimore
Montey, H. A., Cumberland
Mullan, Thos., 4001 Greenmount Ave., Baltimore
Myer, Wm., Baltimore
Penn Construction Co., The, Govanstown
Piel Construction Co., Baltimore

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Shafer & Williams, Baltimore
Swann, H. S., Faulkner
Thomas, Bennett & Hunter, Westminster
Tidewater Portland Cement Co., Baltimore
Vang Construction Co., Cumberland
Wetter, John E., 1107 American Bldg., Baltimore
White, R. B., Baltimore
Whiting-Turner Construction Co., Baltimore
Wilson, Henry H., Baltimore
Winchell & Co., E. L., Mt. Lake Park
Wolfkill, John B., Hagerstown
Zink Bros., Baltimore

Massachusetts

Alco Contracting Co., Boston
Ballentyne, J. O., Peabody
Beaver Construction Co., 113 State St., Boston
Bianchi & Co., A. G., Springfield
Boston Bridge Works, 47 Winter St., Boston
Camarco & Co., M. L., Lee
Bruno & Pettitti, Boston
Bull, R. E., Fitchburg
Coleman Bros., Boston
Collins, J. C., Andover
Cordner & Montague, Springfield
Cressy, Walter, 178 Western Ave., Gloucester
Cressy Contracting Co., 278 Albany St., Boston
Crows & Walsh, Pittsfield
Davis & Brock, Brookline
Duff, John W., Inc., Newtonville
Eastern Bridge & Constructural Co., Worcester
Ellis, F. E., Melrose
Fannon, J. H., Somerville
Fay Construction Co., L. C., 318 Main St., Springfield
Ferguson, J. H., Dorchester
Fisher, Walsh & Baush, Beacon Bldg., Boston
Framingham Construction & Supply Co., Framingham
Gaffey, J. A., Medford
Greenough, G. E., So. Acton
Hanscom Construction Co., Boston
Hart, Linton, 53 State St., Boston
Hassam Paving Co., Worcester
H. E. Contracting Co., Bellevue St., Worcester
Hines Construction Co., Springfield
Howard, A. H., 15 State St., Boston
Kelly, Chas. H., Somerville
Ley, Co., Fred T., Springfield
Loud & Sons Co., W. F., 16 Granite St., Quincy
McDonald Co., John J., 475 Main St., Springfield
McDonough, M., Swampscott
Marshfield Construction Co., Marshfield
Middlesex Construction Co., Medford
Moyniham, T. F., S. Hamilton
Nawn Hugh Construction Co., 82 Savin St., Roxbury
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O'Connell Bros. Co., Holyoke
Pearson, John W., Church St., Newton
Perini, B., Ashland
Rowe Contracting Co., Boston
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Smith Co., W. D., 12 Rockland St., Roxbury
Smith & Romano, Roxbury
Sullivan, W. J., Somerville
Sullivan Machinery Co., 185 Devonshire St., Boston
Tomasello & Co., A. G., Dorchester
Walsh, Daniel J., Pittsfield
Warren Bros. Co., Boston
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Watkins, J. E., Salem
Welsh & Moynihan, Salem
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Michigan

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Anderson, Gust, 356 W. Crescent St., Marquette
Ankey, L. A., 1938 Thomas Ave., S. E., Grand Rapids
Atkinson, R. C., Niles
Bacco, M. J., Iron Mountain
Bailey, Roy, Coronna
Baker, John, 1112 John St., Kalamazoo
Baker Co., R. D., Penobscot Bldg., Detroit
Baldwin, A. W., 1333 Washtenaw Ave., Ann Arbor
Balhoff, Thos., Sandusky
Banhagel, Bernard, Ionia
Barnes & O'Neill, Box 24, Allegan
Bartling & Holmes, Alma
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Beach Mfg. Co., Charlotte
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Berrien Construction Co., St. Joseph
Bishop, S. C., Hillsdale
Blakeslee, C. M., Spring Lake
Blanchard, C. H., Roscommon
Blongren, J. E., Norway
Boone Bros., Holland
Braay Construction Co., W. R., 1972 Grand River Ave., Detroit
Brill, Peter, Zeeland
Bristol, C. F., 44 Beresford Ave., Highland Park
Brooks, C. D., Omer
Bruce, Samuel, Harrison
Builders' Traders Exchange, Association of Commerce Bldg., Grand Rapids
Bye, Carl, Frankford
Bye, Nels, Goetzville P. O.
Campbell & Steadman, Pigeon
Carpenter, O. P., 132 Washington Ave., Muskegon
Chalmers, W. B., Commercial Bank Bldg., Grand Rapids
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Clark & Rogers, East Jordan
Clark, Geo. W., 34 Clinton St., Muskegon
Clayton, Wm., Perry
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Davis, D. N., Clare
Davison, Jas., Vernon
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Enot, Arthur, Watervliet
Ericson, Raynold L., Bessemer
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Hall, M. E., Dryden
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Hassle, Leopold, New Buffalo
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Healy, Dan, Bad Axe
Hicks, Ben, Eaton Rapids
Hicks Engineering Co., Vulcan
Hill, W. T., Prescott
Hilliding & Rabe, 363 Ball Park Blvd., N. W., Grand Rapids
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McCracken, W. W., St. Joseph
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McNabb & Son, John Murray Bldg., Grand Rapids
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Meredith & VanPatten, Allen
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Michigan Roads & Forests, 408-9 Equity Bldg., Detroit
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Moreman & Green, 1229 Thomas St., Grand Rapids
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Neale, Wm., Paw Paw
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Newhall Co., The Walter S., 608 Lafayette Blvd., Detroit
Nichols, H. A., Hastings
Noland & Son, E. C., 425 Cuttingwood Ave., Detroit
Oakley Construction Co., Att. M. J. Hobin, Lansing State Sav. Bank, Lansing
O'Sullivan & O'Hara, 905 6th St., Port Huron
Otis Cement Construction Co., 806-7 Hammond Bldg., Detroit
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Rodger Boiler & Burner Co., Muskegon
Rogers & Son, W. B., Watervliet
Rose & Williams, Beaverton
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St. Joseph Construction Co., St. Joseph
Scherl, C. P., R. R. 6, Battle Creek
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Schultz, Henry, St. Joseph
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Smith, Lee, Box 169, Plainwell
Smith-Sparks Construction Co., Houghton
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Van Nemer & Welch, Jackson
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Viehle & Dinsmore, Turner
Wolverine Portland Cement Co., Coldwater
Woster, Elmer, 436 Hewitt Ave., Marquette
Zaring, D. L., Three Oaks
Zimmer & Zickgraf, Mason

Minnesota

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Balch & Co., H. F., 704 Phoenix Bldg., Minneapolis
Barbeau & Werring, 821 Northwestern Bldg., Minneapolis
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Cole & Quigley, Morris
Concrete Products Co., Elk River
Cravens, Earl, 2008 Fremont Ave., Minneapolis
Dobbelman, Emil, 4232 Colfax Ave. S., Minneapolis
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Enke, H., Lake Benton
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Foster & Come, 3345 5th Ave., S. Minneapolis
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Fraser & Danforth, Guardian Life Bldg., St. Paul
Gould & Howe, Glenecoe
Graham, L. P., Frazee
Groves & Sons, S. J., 105 Kasota Bldg., Minneapolis
Hanlon & Oakes, Lumber Exchange, Minneapolis
Hendrickson & Hohl, McKnight Bldg., Minneapolis
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Improvement Bulletin, The, 16 N. 4th St., Minneapolis
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Johnson & Jepson, Sandstone
Kalman Co., Paul J., Merchants National Bank Bldg., St. Paul
Kasper, Edw., Silver Lake
Larkin, K. S., Barry
Larkin, M. D., Barry
Lenson, Chas. R., 4524 Washburn Ave., S., Minneapolis
Lenson, Evans & Wolkup, Minneapolis
Malloy Bros., Hibbing
Martinson, Eric, Moorehead
Mergens, J. J. & M. S., 401 Kasota Bldg., Minneapolis
Minneapolis Bridge Co., Minneapolis
Oftsie, Isaac C., Grand Rapids
O'Malley, C. J., 512 Kasota Bldg., Minneapolis
Pearson & Co., Sandstone
Petrie, Colburn & Merrill, Anoka
Pogue & Co., C. A., Grand Rapids
Ritchie & O'Connell, 118 E. Hennepin Ave., Minneapolis
Roark Construction Co., Thief River Falls
Sampson, Joe, Mankato
Siems & Co., 514 Guardian Life Bldg., St. Paul
Studer & Manion, Excelsior
Stanley Bros., St. Cloud
Stevens Bros., 15 Piedmont Bldg., St. Paul
Thursdale & Co., H., Bemidji
Weaver, Chas., Anoka
Wethern, J. M., Champlin
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Wilkins & Co., Jas., Park Rapids
Winston Bros., 801 Globe Bldg., Minneapolis
Wright, Robert G., Joy Bros. Motor Car Co., St. Paul

Mississippi

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Beauchamp, W. F., Vicksburg
Bonnable, H. J., Gulfport
Boyd, Sam B., Columbus
Boyd & Bradshaw, Columbus
Brookhaven Gravel Co., Brookhaven
Burt, J. A., Gunnison
Clark, R. T., Natchez
Carothers & Co., Booneville
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Healy Construction Co., Lake
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Mills, W. P., McComb City

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Perkins, J. E., P. O. Box 305, Moss Point
Smith & Middleton, Brookhaven
Stroud, Geo. R., care Maxwell & Doty, Goodwin

Missouri

American Contractor, 500 Reliance Bldg., Kansas City
Buis & Olson, 116 N. 8th St., St. Joseph
Campbell Bros., 207 New England Bldg., Kansas City
Clark & Son, B. F., 5052 Gates Ave., St. Louis
Collings, W. A., 517 Finance Bldg., Kansas City
Concrete Construction Co., 1821 Independence, Kansas City
Cook-O'Brien Construction Co., Room 305 Ry. Exchange, Kansas City
Crane Construction Co., Dan C., Springfield
Dickey Clay Mfg. Co., W. S., Kansas City
East St. Louis Bridge Co., E. St. Louis
Griffiths, Geo. Jr., General & Bridge, St. Louis
Illinois Steel Bridge Co., 412 Title Guarantee Bldg., St. Louis
Kansas City Bridge Co., 1012 Baltimore Ave., Kansas City
Karrc & Conn, Wyatt
Korell, G. W., Box 123, Savannah
Midland Bridge Co., Box 1045, Kansas City
Pioneer Construction Co., Kansas City
Plummer, Adams & Welch, Springfield
Ray Concrete Mfg. Co., Richmond
Republic Concrete Construction Co., Republic
Rich Construction Co., East St. Louis
St. Joseph Structural Co., 4th & Franklin Sts., St. Joseph
O. H. Schmidt, 53 Ballinger Bldg., St. Joseph
Sherwood & Myers, 820-22 Landers Bldg., Springfield
Sullivan Machinery Co., Ry. Exchange Bldg., St. Louis
Sutton, H. A., 703 N. 22nd St., St. Joseph
Union Paving & Construction Co., St. Louis
Weber, Harrison, 6349 Washington Ave., St. Louis
Western Contractor, Box 336, Kansas City
Wetterstrom, E. J., 1117 Rialto Bldg., Kansas City
Wills & Sons, A. V., St. Louis

Montana

Bardsen & Co., R. M. Butte
Birch & Sons, S. Great Falls
Booth & Knipe, Glasgow & Saco
Boynton, M. B., Anaconda
Brady, Earl, Burns
Brown & Leahy, Great Falls
Burke, D. J., Lewistown
Chounard, Lee, Baylor
Clifton, Applegate & Toole, Anaconda
Crawford, C. W., Red Lodge
Delvin, J. H., Gilman
Denton Bros., Billings
Donati, Antone, 59 Front St., Meadersville.
Elliot, Fred, Great Falls
Evans & Co., F. E., Great Falls
Frady, C. H., Billings
Frazier, R. B., Box 1187, Great Falls
Fredericks, R. W., Joliet
Gerharz-Jaqueth, Great Falls
Harkley, Jas., Box 84, Helena
Hayden Bros., 817 5th Ave., No., Great Falls
Higgins, Tom, Rosebud
Hilliard, Lee, Hilger
Hilton & Slack, Malta
Hoem, Peder, Big Timber
Johnson, Chas., Billings
Kemp, D. E., Cascade
Kent, T. E., Cascade
Lord Construction Co., Hamilton
McBrayne, R. A., Farmers State Bank, Havre
McDonald, W. R., Wallum
McLaughlin & O'Neill, Livingston
McVeigh, Peter, Great Falls
Melchert, B. P., Lewistown
Metcalf, Robert, Butte
Monarch Construction Co., Bozeman
Musgrove, Wm., Box 141, Roundup
Nelson-Rich Co., Ronan
O'Connor, Pat, Missoula
O'Neill, Jas., Fort Benton
Prahl, E. J., Miles City
Randall, A. E., Galata
Saversey, Frank, Billings
Security Bridge Co., Billings
Soden & Heyen, White Sulphur Springs
Tengman, J. W., Miles City
Tillman, Wm., Musselshell
Tuohy, M. H., Marysville
Tupper, Renshaw & Wells, Roundup
United States Bridge Co., Great Falls
Velguth, Ben Billings
Walker, Wm., Roundup
Weast, J. P., Roberts
Wesch & Berry, Billings
White & Rich, Bozeman
White, R. J., Great Falls
Youngken, J. H., Dillon

Nebraska

Arthur, J. N., care Lincoln Hotel, Lincoln
Beaty Construction Co., Blair
Beebe, John, 1711 Sahler St., Omaha
Beeman, E. W., 3716 Cumming St., Omaha
Byrne, Harry S., 326-7 City Nat'l Bank Bldg., Omaha
Caniglia, A., 1020 S. 11th St., Omaha
Capitol Bridge Co., Lincoln
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Condon, Geo W., 415 Farnam Bldg.,
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Dugan, W. H., 820 N. 32d St., Omaha
Edwards, Mont., Pawnee City
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Fanning, Chas. E., Omaha
Freeland Bros., 1116 Farnam St., Omaha
Galion Iron Works, 126 N. 20th St., Lincoln
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Gilland, A. S., Lexington
Green, R. O., Court House, Hastings
Gross, C. N., 106 W. 27th St., Kearney
Higgins & McDonnell, Fairbury
Jones, C. I., 225 N. 16th St., Lincoln
Lamoreaux Bros., 805 Brandeis Bldg., Omaha
Lehmer Bros., 1846 Emmett St., Omaha
Look, Frederick W., 4814 Capitol Ave., Omaha
Malone, Robert, Lincoln
Miller, C. R., Lincoln.
Morrow, R. W., 5006 Burt St., Omaha
Nebraska & Iowa Steel Tank Co., Omaha
O'Hanlon & Reilly, 3220 Poppleton Ave., Omaha
Omaha Structural Steel Bridge Co., Omaha
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Peterson, Ed., 1402 W. O. W. Bldg, Omaha
Phelan & Shirley, Omaha
Roberts Construction Co., Lincoln
Schlueter Bros., Oakland.
Schoeneman, C. H., Lexington
Sears, A. D., Chadron
Sprague & Nicely, care of Kilpatrick Bros., Beatrice
Standard Bridge Co., Omaha
Stroud & Co., Omaha
Thomas, Frank, Nebraska City
Wachter, Don A., Lincoln State Bank, Lincoln
Walworth, E., Lincoln
Western Bridge & Construction Co., Omaha
Western Contractor, Lincoln
Western Wheeled Scraper Co., 916 Farnam St., Omaha

Nevada

Amer. Ovehrauling & Contracting Co., The, 442 Gazette Bldg, Reno
Barner, V. S., Box 625, Reno
Barlow, A. H., Mason
Berney, E. S., Fallon
Botti, Mose, Carson City
Boyd, I. D., Halleck
Brady, S. H., 800 Wheeler Ave., Reno
Causten, J. H., Lovelock
Churchfield, J., Deeth
Davis, W. W., Yerington
Flanigan Warehouse Co., Reno
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Gerahty, M. P., 103 Colonial Hotel, Reno
Jameson, C. D., Box 95, Reno
Jenson, Earl, Yerlington
Johns, Dan, Lamoille
Kaeding, Geo. L., Battle Mountain
Kirchen, Chas., Box 30, Reno
Leak, E. C., Ely
Lewis, C. H., Deeth
Licking, Wm. L., Battle Mountain
Lincoln Construction Co., Ely
Little, L., Frandsen Apts., Reno
Ludwick, T. E., Fallon
Moran, Bernard J., Box 862, Tonopah
Nevada Construction Co., Fallon
Nevada Implement & Supply Co., Reno
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Niedt & Gavin, Box 736, Reno
Nixon & Hoffman, Yerington
O'Keefe, John, Goldfield
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Reading Bros., Wellington
Reilly, Hugh W., Yerington
Richardson, W. V., Tonopah
Ross, Mr., Yerington
Simpson, F. W., Simpson
Sullivan, F. B., Carson City
Taylor, L. H., Oddfellows' Bldg., Reno
Verdi Lumber Co., Reno
Van Negell, J. R., Riverside Mill Co., Reno
West, Neill, 445 Sierra St., Reno
Wittenberg Warehouse & Transportation Co., Tonopah

New Hampshire

Cavanaugh, J. F., Manchester
Davis, Louis, Sunapee
Emerson, W. E., Fitzwilliam
Malloy, Thos., Gorham
Robie Consolidated Concrete Co., Manchester
Thomas & Murphy, 86 Winter St., Keene
Winslow & Cummings, Nashua

New Jersey

Abraham, Ernest, Hackensack
Atlantic Supply & Con. Co., Atlantic City
Bader, Edw. L., Atlantic City
Baker, Wm., Jersey City
Bamberger & Chapman, East Orange
Barrett, Jas. J., 147 Lafayette Ave., Trenton
Barrett, Thomas J., Fieldsboro
Brackett, Geo. F., Ridgewood
Brewster Con Co., Tenafly
Burke, Jos. F., Plainfield
Byram, F. C., Red Bank
Cassedy & Holman, Cape May City
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Collins & Gundrum, South Amboy
Commonwealth Quarry Co., Summit
Corson, Everton A., Ocean City
Cranmer & Parker, West Creek
Cruchfield, W. T. S., 82 Washington St., Hoboken
Delaware River Quarry & Const. Co., Lambertville
DeLucia, Antonio, 52 Bayard St., Trenton
Demarest, Irving, 790 Broad St., Newark
Donnelly & Shannon, Ridgewood.
Donovan & Son, D., Bayonne
Dorer, John, 646 Nye Ave., Irvington
Doriety, John, Newark
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Gibbs, Willard T., Clementon
Glenfield Const. Co., Newark
Gougherty, J. B., Morristown
Hafeman, Richard, Freehold
Hardgrove, Wm., Somerville
Harrop & Co., John T., Somerfield
Heyman & Goodman Co., 15 Exchange Pl., Jersey City
Highway Improvement & Repair Co., Caldwell
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Holman, F. T. & L. W., Atlantic City
Humphreys, E. C., Inc., Hackensack
Ingersoll, John W., Atlantic City
Janorone, Philip & Peter, Belleville
Kavanaugh, Chas. T., Inc., Bayonne
Kiernan & Bergen, Paterson
Knowles, W. H., P. O. Box 351, Camden
Langan Eng. & Const. Co., Jersey City
Liddle & Pfeiffer, New Brunswick
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McGarry, John J., Edgewater
McGovern, Thos. J., Trenton
McMullen, Robert F., Janeva Pl., Haddon Heights
Martin Bros., Yardville
Mears, Wm., Seabright
Miller, Edw. M., 641 Hughes St., Cape May City
Miller, L. E., Cape May
Monmouth Contracting Co., Red Bank
Mulrey, John E., 306 W. State St., Trenton
Murtland, John, Atlantic City.
Newark Paving Co., Newark
Nolan & Hornung Const. Co., West Hoboken
Northern Construction Co., Newark
O'Neill, Edw. P., Jersey City
Osborn & Marsellis, Montclair
Powell & Fox, Ocean City
Remington, J. C., C. H. Square Bldg., Camden
Richards & Gaston, Somerville
Riddle, Thos., New Brunswick
Ritter, John T., Morristown
Sands, Kline Co., Morristown
Sangiovanni, Ralph, 80 Hoyt St., Newark
Schaefer, W. H., 432 Market St., Camden
Scott Contracting Co., H. N., Cranbury
Salmon Bros., Netcong
Sebolt, Conrad, New Brunswick
Sigafoos & Poore, Rieglesville
Smith Bros., Hackettstown
Staub, Michael J., Grenloch
Stocker, F. W., Inc., 1031 Clinton St., Hoboken
Sutton & Corson Co., Ocean City
Sweeten & Son, B. F., Camden
Union Bldg. & Const. Co., Passaic
Utility Construction Co., New Brunswick
Van Keuren & Son, Jersey City
Weldon Contracting Co., Rahway
Wigglesworth, E., Collingswood
Wilhelms Sons Co., H., 803 E. Jersey St., Elizabeth
Winans Co., C. H., Linden

New York

American Bridge Co., 30 Church St., N. Y. City
Atlanta Construction Co., Wayland
Aylett, Philip, Garrison St., Hollis, L. I.
B. & R. Transportation Co., 238 Spencer St., Brooklyn
Baker-Barron, Inc., 221 W. Broadway, New York City
Barett Co., The, 17 Battery Pl., New York City
Barker-Bonner, Inc., 18 E. 41st St., New York City
Belmar Contracting Co., The, Troy
Beskin, Samuel, Beacon
Blaisdell Contracting & Engineering Co., 238 Spencer St., Brooklyn
Blaw Steel Construction Co., 165 Broadway, New York City
Brayer Bros., Auburn
Breed, H. E., Albany
Breese & Church, Elmira
Briggs, Geo. W., 434 Huntingdon Ave., Buffalo
Brotsch Co., Frank W., Rochester
Buffalo Cement Co., Ltd., The, 110 Franklin St., Buffalo
Buffalo Steam Roller Co., Buffalo
Butler S. Frank 101 Park Ave., New York City
Cadmus Construction Co., 120 Liberty St., New York City
Cannon Engineering Co., 1297 Metropolitan Ave., Brooklyn, N. Y.
Carlin Contracting Co., P. J., 1123 Broadway, New York City
Carmp & Co., 25 E. 26th St., New York City
Chanango Construction Co., Albany
Cheslet, Earl & Heimbach Co., 20 Breckenridge St., Buffalo
Chester, F. J., Room 1605 Woolworth Bldg., New York City
Cleveland & Sons Co., Brockport
Cohen, Frank L., 49 Niagara St., Buffalo
Cold Springs Construction Co., Buffalo
Cole, H. J., 5 Pine St., Albany
Constantine Construction Co., Buffalo
Construction Service Co., 15 William St., New York City
Coughlin, Wm. J., 38 Park Row, New York City
Crouch, Jesse J., Rochester
Dale Engineering Co., Utica
Defiance Corp., The, Ticonderoga
DeGraff & Hogeboom, Inc., Kingston
Dolan Contracting Co., John T., 50 Church St., New York City
Dugan, D. D., Olean
Dugan & Co., Inc., John P., Amsterdam
Engineering News Record, 36th & 10th Ave., New York City
Fearl, Herbert W., Potsdam
Foley Contracting Co., E. W., 71 Wall St., New York City
Foote, Frank J., Nunda
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Fox Construction Co., Harry E., 81 E. 25th St., New York City
Francisco Bros., Little Falls
Franklin Contracting Co., 52 Vanderbilt Ave., New York City

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Good Roads, 150 Nassau St., New York City
Grady, Thos., Rochester
Greenfield Construction Co., Hornell
Griffin, Frank D., Norwich
Griffin & Griffin, Norwich
Guinan Contracting Co., 2310 Gravesend
Gurnett, John W., Watkins Ave., Brooklyn
Halton, Wm., 153 Stevens Ave., Mt. Vernon
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Harlem Contracting Co., New York City
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Healy, P. J., 30 Church St., New York City
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Hildreth & Co., 15 Broad St., New York City
Hopkins, Richard, Troy
Hyland-Jencks, 507 5th Ave., New York City
Indian Refining Co., 17 Battery Pl., New York City
Indiana Refining Co., 44 Madison Ave., New York City
Johnson Construction Co., John, Buffalo
Johnson, Sydney K., Norwich
Johns, Wm. H., care of Chas. T. Murphy, Jr., 80 Maiden Lane, New York City
Kaufman & Garcey, 51 Chambers St., New York City
Kelley, Jas. P., Cohoes.
Kennedy Construction Co., Inc., Utica
Kennedy, Roger B., Utica
Kennedy, Thos B., Albany
Lackawanna Bridge Co., P. O. Box 97, Buffalo
Langhorne Co., Inc., 2 W. 45th St., New York City
Latus, Elmer J., Albany
Law, Wm. J., care of Newport Construction Co., Herkimer
Lawton, W. L., Glens Falls
Lounsbury & Sons Co., Peekskill
McCarthy & Wall, Mt. Morris
McDonald Construction Co., Wm. P., Mt. Vernon
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McMullen Co., Arthur, Singer Bldg., New York City
Macarthur Bros., 120 Broadway, New York City
Mallory & Walsh, Brooklyn
Malloy, J. J., Schnectady
Malloy & Murray Contracting Co., Yonkers
Mexican Petroleum Co., 120 Broadway, New York City
Milliken Bros., Milliken, S. I.
Monroe Roads Co., Pittsford
Mott, Daniel L., Utica
Municipal Journal, 243 W. 39th St., New York City
Murphy, Jr., Chas. F., 80 Maiden Lane, New York City
Murray, John M., LeRoy
Murray, P. H., Rochester
Murray, Thos. F., LeRoy
Neumeyer & Dimond, 82 Beaver St., New York City
N. Y. State Road Builder's Asso., 22 Pearl St., New York City
O'Brien Construction Co., Grand Central Terminal, New York City
Paddleford & King, Sherburne
Page, Wm. D., Supervisor, The Town of Perry, Perry
Pathfinder Construction Co., Inc., Fulton
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Ribstein-Holter Co., Inc., Rochester
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Robertson, Inc., Quinlan, 489 5th Ave., New York City
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Schroeder, H. C., Rochester
Schwiers Co., F. W., Jr., 90 West St., New York City
Serafini, Geo., 54 Court St., Binghamton
Serafini & Stento, Binghamton
Sieling, Louis J., 171 Madison Ave., New York City
Simpson, C. R., 90 West St., New York City
Sproul Construction Co., Inc., Peekskill
Standard Bitulithic Co., 50 Church St., New York City
Standard Oil Co. of New York, 26 Broadway, New York City
Stewary-Willey Co., 1123 Broadway, New York City
Stocker, Inc., F. Wm., 1031-3 Clinton St., Hoboken
Suburban Engineering Co., 15 W. 338th St., New York City
Sullivan Machinery Co., 30 Church St., New York City
Thayer & Co., W. T., Chateaugay
Transcontinental Engineering Co., 1400 Broadway, New York City
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United States Asphalt Refining Co., 90 West St., New York City
Van Wagenen, Inc., S. B., Rondout
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Wildon-English Construction Co., 50 Church St., New York City
Wilkes-Casey Contracting Co., The, New Rochelle
Wilkins, J. D., Corrugated Bar Co., Buffalo
Wing & Munger, Holly
Young, Nathan E., Union
Young & Hyde, Produce Exchange Bldg., New York City

North Carolina

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Curtis & Co., R. W., care of Hotel Frances, Winston-Salem
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Guion & Co., A. H., Gaston
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Justice, M. L., Rutherfordton
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Patton Bros., Marshall
Plotts, J. T., Greensboro
Porter, C. L., Snow Hill
Porter & Boyd, Charlotte
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Reed & Wells, Asheville
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Schlitz & Ginn, Lowell
Simmons, Whitton & Co., Charlotte
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Wilson, R. V., Nebo
Wright-Johnston Contracting Co., Andrews

North Dakota

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Beard, Fred, Thompson
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Bliss, Jay W., Valley City
Burke, Thos., care of Soo Hotel, Bismarck
Burke, Thos., Driscoll
Burns, Andrew, Grand Forks
Culp, C. A., New Rockford
Dickinson Ice & Transfer Co., Dickinson
Druhl & Kemper, Minot
Dunahey, Chas., Sanger
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Knowlton & Sons, Bowbells
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Paulson, August, Ryder
Rasmussen, F. W., La Moure
Schmitt, H. E., Bowden
Schultz, W. G., Bowbells
Skjonhaug & Van Pelt, Bowman
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Stiles, Ezra, Hazleton
Sweeney & Wimmill, Bowman
Treadwell & Twinchell, Mapleton
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Yeaman, Jas., Devils Lake
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Adams Bros. Contracting Co., Zanesville
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Aller, S. A., LaRue
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Bauer, Geo. J., Pomeroy
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Bean, Ed., Highland
Beatrice & Kiener, Moxahala
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Beightler, Robert S., Marysville
Beighton & Spaulding, Pioneer
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Bowers & Wilson, Lancaster
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Masters & Mullen Construction Co., Electric Bldg., Cleveland
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Northern Construction Co., The, Bellevue
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O'Bryant & Gregg, Marysville
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Ohio Engineering & Supply Co., Cleveland
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Patterson, Allen, Lima
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Patton, W. W., Woodsfield
Paul, Bowers & Elsass, Botkins
Paul & Henry, Barberton
Paulin, Wm. Jr., West Middletown

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Perry, J. F., Chillicothe
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Peters & Palmer, Marietta
Petit & Abels, Zanesville
Petrie & Long, Logan
Phillips, D. A., Ashland
Phillips & Drury, Malta
Porter, John, Marysville
Potter, G. F., Merchants Bldg., Cleveland
Powell, W. F., Perrysburg
Prechter, Peter, Cincinnati
Pryor, J. A., Byesville
Public Construction Co., Elyria
Pugh, A. G., Columbus
Purdum & Schwartz, Shepard
Putnam, Isaac, 512 E. Main St., Van Wert
Quigley, W. H., McConnellsville
Ralston, W. H., Mt. Vernon
Raymer, John D., Toledo
Raymond & Caldwell, Galion
Rea, A. S., Brown Hall, O. S. U., Columbus
Ready, A. H., Warren
Redebaugh, E. C., Logan
Remheimer, C. L., New Paris
Renick, H., Williamsport
Reubel Construction Co., John, Cincinnati
Rice, C. H., Belmont
Rice & Sons, F. L., Shelby
Richards, David C., Rio Grande
Ricketts, K. R., Mt. Vernon
Riddle, C. W., Delaware
Rimelspach & Thomas, Fremont
Rinehart Bros., East Liverpool
Ringwald & Sons, W. H., Chillicothe
Roach, R. C., Waterville
Robinson, Jas. W., Waverly
Roof & Barton, Sunbury
Rosche, F. C., 29 Lakewood Ave., Cincinnati
Rosser & Maloney, Bellaire
Rousch, John, Rt. 2, Ironton
Rousch, J. A., 328 Spring St., Ironton
Rousch & Wooleum, Pedro
Rudy, E. E., Orrville
Rusk Construction Co., J. W., Mansfield
Ryan, C. W., Maumee
Ryan, John P., 1112 1st National Bank Bldg., Cincinnati
Sapp, B. E., Mt. Vernon
Sates, J. F., Logan
Schultz, A. C., Sandusky
Scott, E. A., Marion
Scott, G. E., Norwalk
Scott, J. W., Springfield
Seaborn, Thos. J., Youngstown
Sedgwick, F. M., Medina
Seguine, John, Findlay
Seipple & Wolf, Youngstown
Senter, S. S., Canton
Shafer, Oliver G., Caldwell
Shafer, Richard, 2d St., Findlay
Shannon, H. D., Orrville
Shannon & Wildeson, Orrville
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Sheedy, J. S., 102 Landan St., Urbana
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Sheridan & Kirk Co., Portsmouth
Shilling Construction Co., Youngstown
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Skeldon Engineering Co., The Jos. L. Toledo
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Smith, C. O., Williamsport
Smith, Chas. F., Dayton
Smith, Edson C., 1104 Nevada St., Toledo
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Snouffer, J. M., 8 E. Broad St., Columbus
Snyder, A. E., Trenton
Souder, W. H. & H. A., Fostoria
Sousley & Botkin, Ada
Sparhawk, Wm. T., Rt. 8, Tallmadge
Spence Bros., 12409 Euclid Ave., Cleveland
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Springer & Rogers, New Philadelphia
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Statz, Chris, Bellevue
Stayle, J. A., Mt. Vernon
Stayton, R. W., Eaton
Steele, H. E., Mt. Healthy
Stoible, Thos., Cincinnati
Stowe, John M., Columbus
Strack, Thos., 31 Goodall Bldg., Cincinnati
Strodbeck Bros., Middletown
Sullivan & Son, D. E., Interurban Terminal Bldg., Columbus
Sullivan, M. D., Chillicothe
Swank & McIntyre, 120 Shaw Ave., Dayton
Sweeney, John H., Marion
Sweeney, P. H., Troy
Swingle Contracting Co., J. A., Zanesville
Swint Bros. Construction Co., Fremont
Tanner, S. M., Cincinnati
Tapper, J. M., Kitts Hill
Terrell, R. H., Highland
Texas Co., The, Madison Ave. & Superior St., Toledo
Thoenen, J. H., 510 N. Broadway, Greenville
Thomas, L. G., Gillespieville
Thomas Construction Co., Sandusky
Thuber & Co., Cincinnati
Timmons, R. L., Cadiz
Townsend, Frank T., care Dun Wire Cut Brick Co., Conneaut
Trinway Washed Gravel Co., Zanseville
Tri State Exchange, 219 Ohio Bldg., Toledo
Turnbull Bros. & Co., Canton
Turner, A. W., 700 Lincoln Ave., Toledo
Turner, E. N., Logan
Turner-Olson Construction Co., Youngstown
Tweed, Geo. & Albert, Vigo
Ule, W. E., Kent
Union Contracting Co., Bellefontaine
Van Camp Bros., Newtonville
Voelker, Jas. C., Thurman
Vogelmeier, Chas., Newark
Vogt Sons, Wm. H., Massillon
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Westrick & Lime, Holgate
Wheeler, John M., Cadiz
Whitham, C. G., Deshler
Wildes & Davidson, Akron
Williams & Little, Cleveland
Willis, T., Chillicothe
Wilson, R. E., Youngstown
Wilson Contracting Co., Newark
Wilson Engineering & Construction Co., Xenia
Wirtz Transfer Co., A., Hamilton
Wise Bros., Canton
Woods, Grover C., Lodi
Woolley, W. C., Marion
Wortman, E. C., Hamden
Wright, Chas. L., Cincinnati
Wright, N., Lisbon
Wright & Chessell, Kent
Wrightsel, Samuel W., Logan
Wroe Bros., Dayton
Young Contracting Co., L. H., Austintown
Yount & Jackson Co., Dayton
Zeis, H. D., Tiffin
Zeller, Henry G., Swanton

Oklahoma

Ables, John T., Madill
Adam, L. F., Waukomis
Addington, O. B., Addington
Alderson, John, Perry
Alta Oil & Development Co., Tulsa
Anderson, J. H., Keota
Armstrong & Coates, El Reno
Armstrong & Teenor, Vinita
Babb, C. T., Nowata
Ball, S. M., Watonga
Bayer, Paul R., Fairview
Benham Eng. Co., Oklahoma City
Boardman Co., The, Oklahoma City
Bogges, R. A., Duncan
Burnham, I. A., Buffalo
Burns, Benj., Geary
Chisum, J. C., Altus
Chisum, Lee, Aetas
Clark, W. M., Pawhuska
Coatney, John, Chandler
Collins, G. G., Ringwood
Combs, C. L., Duke
Conkling, I. H., Eagle City
Connelly Const. Co., Bartlesville
Cooper, D. S., Greenfield
Couchman, C. G., Geary
Dillard, W. F. & I. Trope, Lawton
Duffy, E. P., Pauls Valley
Ellis, Tom, Ardmore
Fay, W. P., Stilwell
Froebe-Gray Const. Co., Muskogee
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Harper, L. M., Granite
Harrison Const. Co., J. J., Henryetta
Hays, Al., Atoka
Headrick, J. R., Ringwood
Heflin, W. T., Wister
Henry, W. B., Mangum
Herber, Mike, Ponca City
Herman, Budd, Hitchcock
Hightower & Cornelius, Rush Springs
Hinckley, H. V., Oklahoma City
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Huffman, J. D., Waurika
Hungerford, Chett W., Garfield County
Hurst, G. M., Kiamicha
Innis, J. E., Woodward
Jobert, H. F., Duncan
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Kern, J. D., Pawnee
Krey, J. P., Minco
Landon, C. G., Oklahoma City
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Lennen, Fred, Cleo
Lewallen, E. L., Duncan
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Longwill, Ames
Looney, J. E., Tishomingo
Lyman, E. W., Eufaula
McCartney, S. B., Valliant
McClung, Atoka
McFenon, C. W., Box 411, Tulsa
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McReynolds, J. E., Fairview
Mann Co., The Oklahoma City
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May, A. F., Anthers
Miller, N., Longdale
Miller, S. R., Taloga
Moore, Leo A., Clarmore
Moore, Warren E., Oklahoma City
Mullins, C. H., Pawnee
Muns, Geo. F., Enid
Nelson, John J., Longdale
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Odem, L. F., Waukomis
Oklahoma Bridge Co., Oklahoma City
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Olson, Alfred, Laverne
Olson, Chas. S., Guthrie
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Palmer, W. P., Pocasset
Patterson, W. L., Antlers
Pearce & Palmer, El Reno
Poulton, P. E., Boise City
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Rayls, P. E., Belva
Reily, C. V., Farry
Richardson, C. E., Greenfield
Roach, Clyde & Charley, Waukomis
Roberts, O. E., Norman
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Rooks, John W., McAlester
Rose, Foster, Galena
Rourk, G. F., Belva
Sampley, D. C., Berwyn
Sandford, F. M., Arnett
Sawyer, L. E., Fairview
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Shull, C. G., Hugo
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Taylor, C. H., El Reno
Terry, E. L., Wayne
Terry, J. S., Poteau
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Van Winkle Const. Co., Muskogee
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Wallace & Beman, Ponca City
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White, L. B., Duke
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Wohlgehagen, Henry C., Geary
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Yahola Sand Co., Muskogee
Zentz, W. W., Covington
Zimmerman, C. G., Isabella
Zimmerman & Helcl, Watonga

Oregon

Anderson, Albert, Grants Pass
Blake-Compton Co., McMinnville
Dennis Const. Co., V. R., McMinnville
Elliott & Scoggin, McKay Bldg., Portland
General Const. Co., Northwestern Bank Bldg., Portland
Guthrie & Co., A., Sherlock Bldg., Portland
Hampshire & Co., John Grants Pass
Hawley & Co., J. H., Divide
Heintz, O. E., Portland
Herrold, L. O., 303 Henry Bldg., Portland
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Huber, Oscar, 227 Sherlock Bldg., Portland
Johnson Contract Co. 311 Lumber Exchange, Portland
Joplin & Eldon, 702 Gasco Bldg., Portland
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Porter & Conley, Railway Exchange Bldg., Portland
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United Contracting Co., Northwestern Bank Bldg., Portland
Warren Construction Co., 700 Journal Bldg., Portland

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Barber Asphalt Paving Co., 1900 Land Title Bldg., Philadelphia
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Beck, Edw. T., 116 St. Clair St., Warren
Bell, Gilbert A., 1802 Commonwealth Bldg., Pittsburgh
Bennett & Sons, M., Indiana
Best, Mathew J., 2244 E. Allegheny Ave., Philadelphia
Bird, Howard M., 44 Union Trust Bldg., Harrisburg
Birdsboro Stone Co., 614 Bulletin Bldg., Philadelphia
Blaw Steel Const. Co., Box 915, Pittsburgh
Booth & Flinn, Ltd., 1942 Forbes St., Pittsburgh
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Breckenridge Const. Co., R. J., Grove City
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Bushkill Quarry & Const. Co., Bushkill Drive, Easton
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Central Construction Supply Co., 222 Market St., Harrisburg
Coon Construction Co., B. G., 274 Union St., Luzerne
Cooper, A. B., Johnstown
Coryell, B. H., Williamsport
Craven, Wm. D., Jr., Ridley Park
Crescent Portland Cement Co., Wampum
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Day & Zimmerman, Philadelphia
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Dodge Co., F. W., 1821 Chestnut St., Philadelphia
Donora Construction Co., Inc., Donora
Downey Contracting Co., Penn Bldg., Philadelphia
Downing Sand & Gravel Co., P. O. Box 564, Erie
Drawbaugh, Walter H., Dover, York Co.
Dunleavy Bros., Room 9, Pennegar Bldg., Coatesville
Eastburn, Chas. T., Yardley
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Felton, Lewis, Everett
Ferguson & Edmondson Co., Pittsburgh
Field, Barker & Underwood, 620 Commercial Trust Bldg., Philadelphia
Finch, N. G., 213 S. 5th St., Reading
Finn & Son, P. W., 17 Masonic Temple, Altoona
Fireproof Materials Co., 550 Century Bldg., Pittsburgh
Fiss, R. C., Shamokin Dam
Foster, S. D., 2120 Farmers Bank Bldg., Pittsburgh
France Slag Co., Erie
Frey-Hostetter Co., York
Galion Iron Works & Mfg. Co., 341 Oliver Bldg., Pittsburgh
Gaynor Contracting Co., Board of Trade Bldg., Scranton
General Construction & Engineering Co., 1530 Real Estate Trust Bldg., Philadelphia
General Crushed Stone Co., 417 North American Bldg., Philadelphia
General Crushed Stone Co., Drake Bldg., Easton
Giles & Ransome, 1008 Commonwealth Bldg., Philadelphia
Gilmore Sand Co., Inc., A. R. Linden, Lycoming Co.
Goodcharles, Walter A., Milton
Good Roads Machinery Co., 2037 Commercial Trust Bldg., Philadelphia
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Harris, Geo. M., Meadville
Haup, G. Edw., Bellefonte
Hayes, John Blakeslee, Monroe Co.
Headley Good Roads Co., Franklin Trust Bldg., Philadelphia
Hengst, R. G., New Castle
Henry, W. Walter, Lincoln Trust Bldg., Altoona
Herrick Construction Co., 55 Bennett Bldg., Wilkes-Barre
Hileman & Co., L. H., 217 National Bank Bldg., New Kensington
Hinkle, H. G., 61 Central Trust Bldg., Altoona
Hite, W. L., Sewickley
Hoblitzell & Price, Meyersdale
Holcombe, P. A., 1602 Finance Bldg., Philadelphia
Hoover Wagon Co., York
Horton & Co., Irving S., Contractors & Engineers, Reading
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Jackson, Frank T., 9th & Peach Sts., Erie
James, E. Arthur, 307 Johnstown Trust Bldg., Johnstown
Johnson Oil Refining Co., 908 Union Arcade Bldg., Pittsburgh
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Juniata Co., The Empire Bldg., Philadelphia
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Keystone Trappe Rock Co., Glenmoore
Kirk, David M., 1529 Oliver Bldg., Pittsburgh
Koppel Industrial Construction Co., Pittsburgh
Kramer, K. F., P. O. Box 250, Harrisburg
Lakewood Engineering & Construction Co., Widener Bldg., Philadelphia
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Lavino & Co., E. J., 470 Bulletin Bldg., Philadelphia
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Loomis & King, Altoona
Love & Son, E. M., Corry
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McBride & Co., Wm., 128 S. 2nd St., Harrisburg
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McGovern, P. E., Punxsutawney
McGuire Co., J. G., New Brighton
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McIntire & Son, Wm., Sharon
McKay, W. N., New Burlington
McKenna, F. B., Widener Bldg., Philadelphia
McMahon, Est. of David Main & Chelton Ave., Germantown, Phila.
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McNichol Paving & Construction Co., 1923 Cherry St., Philadelphia
Manawaring & Cummins, Inc., 2432 E. Church Lane, Philadelphia
Marshall, Fred L., 308 Webster Ave., Scranton
Martin Bros., 4905 Penn Ave., Pittsburgh
Martino & Bevacqia, 680 E. Main St., Bradford
Mason & Hanger Co., Chambersburg
Matson Bros., Brookville
Mayer Bros. Construction Co., 312 Commerce Bldg., Erie
Mayer Brick Co., C. P., Bridgeville
Meckes, Franklin P., Long Pond
Mellon & Stuart, Oliver Bldg., Pittsburgh
Mellon, E. A., Hotel Dauphin, Harrisburg
Metz, L. Vincent, 632 State St., Erie
Miles, J. E., Easton
Miller, Ben F., Meadville
Mills-Tighe Construction Co., 609 Drake Bldg., Easton
Moffitt, R. H. Jr., 1705 N. Front St., Harrisburg
Monroe Paving Co., Langhorne
Monroe Paving Co., Shamokin
Mueller, H. A., 524 Frick Bldg., Pittsburgh
Munro & Co., Thos. W., DuBois
Murphy, J. R., 238 Noble Ave., Crafton
Myers, R. R., Lewistown
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Neefe, L. F., 317 Chestnut St., Harrisburg
Neelen & Daly, 2529 Perrysville Ave., N. S., Pittsburgh
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Neylon, Thos. E., 217 9th St., Renovo

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Offutt, Jas. H., Greensburg
Oliver, F. P., 1257 Tenn. Ave., Dormont
Penn-Allen Cement Co., 542 Widener Bldg., Philadelphia
Penn Bridge Co., Beaver Falls
Pennsylvania Cement Co., 813 Commercial Trust Bldg., Philadelphia
Pennsylvania Clay Co., Germania Bank Bldg., Pittsburgh
Pennsylvania Sales Co., 18 Harrisburg Natl. Bank Bldg., Harrisburg
Philadelphia Paving Co., 1345 Arch St., Philadelphia
Phillips, John J., LaPlume
Phoenix Portland Cement Co., 1112 Real Estate Trust Bldg., Philadelphia
Pitt Construction Co., The 1227 Fulton Bldg., Pittsburgh
Pitts, A. F., 1102 Farmers Bank Bldg., Pittsburgh
Pittsburg Bridge & Iron Works, 1205 Farmers Bank Bldg., Pittsburgh
Pomeroy, J. N., Chambersburg
Porter, Jas. M., 1120 Park Bldg., Pittsburgh
Portland Cement Asso., Farmers Bank Bldg., Pittsburgh
Prindible, Wm. C., Patton
Quinn, M. P., 612 Fidelity Bldg., Philadelphia
Rae, W. S., 439 Oliver Bldg., Pittsburgh
Raymond, Jackson, Corry
Reing & Co., Mahanoy City
Rivolta, J. L., 417 Bessemer Bldg., Pittsburgh
Rizzuti & Chiodo, Bradford
Roberts & Co., Edw. G. 264 Frick Annex, Pittsburgh
Rockwell, G. W., Sunbury
Rogers, D. J., 718 Front St., Danville
Rose, W. J., Div. Frt. Agt., Pa. R. R., Harrisburg
Rust Engineering Co., 414 Pennsylvania Bldg., Philadelphia
Rutan, John W., 1305 Arch St., Philadelphia
Ryon, John P., Pottsville
Saupp Co., W. W., 2102 W. Chestnut Ave., Altoona
Seaman, Irwin & Brenneman, Honesdale
Shanley Co., The J. F., 400 Commercial Trust Bldg., Philadelphia
Shannon Co., The J. Jacob Nicholson
Shields, Moses, Nicholson
Shoemaker, W. F., Good Roads Machinery Co., Hummelstown
Silvester & Co., M., 1326 Vickroy St., Pittsburgh
Souder Construction Co., Lancaster
Sprague & Henwood, Scranton.
Standard Contracting Co., Altoona Trust Co. Bldg., Altoona
Stewart Contracting Co., Easton
Stover, Amos E., Palmyra
Strucker Bros. Construction Co., 9 Russ Bldg., Harrisburg
Susquehanna Stone Co., Williamsport
Sutton, E. R., Philadelphia
Sutton & Carson Co., 9th & Simpson Sts., Philadelphia
Sutton Contracting Co., Philadelphia
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Sweeney, Thos., 415 Evaline St., Pittsburgh
Talcott, F. L., 716 Commerce Bldg., Erie
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Terwillinger Equipment Co., 2013 Market St., Philadelphia
Torrington, W. J., 1524 Chestnut St., Philadelphia
Union Paving Co., 30th & Locust Sts., Philadelphia
Union Supply Co., 302 Board of Trade Bldg., Scranton
United Fire Brick Co., Uniontown
United Gas Improvement Co., Broad & Arch Sts., Philadelphia
Universal Portland Cement Co., 524 Frick Bldg., Pittsburgh
Wallace, E. N., Johnsonburg
Walsh, Thos. W., 110 Barber St., Exeter
Warren, Moore & Co., Colonial Trust Bldg., Philadelphia
Whittaker-Glessner Co., 1234 Hamilton St., Philadelphia
Wickersham, B. F., Kennett Square
Widenor, A. K., 642 N. Washington Ave., Scranton
Worcester, W. E., 725-6 Commercial Trust Bldg., Philadelphia
York Bridge & Construction Co., G. W. Drury, Pres., York

Rhode Island

McCormick, Joseph, East Providence

South Carolina

Blankenship & Elliott, Spartanburg
Blassingame, Tom, Greenville
Chitwood & Palmer, care L. A. Chitwood, 1109 Price St., Columbia
Cooley, Jack, Greenville
Gregory, J. M., Gaffney
Jordan, G. C., Gaffney.
McGehee, J. L., Greenville
Massey & Co., Rock Hill
Slattery & Henry, Inc., Greenville

South Dakota

Anderson Construction Co., Rapid City
Atkinson, C. H., Watertown
Butler, W. H., Sturgis
Dunn Construction Co., The Clear Lake
Gage, L. E., Sioux Falls
Gilbert Mfg., Co., The Aberdeen
Johnson Construction Co., Brookings
Jrugenson, Henry, Aberdeen
Ledgard, E. G., Sioux Falls
O'Leary, Ben Timber Lake
Parris & Matson, Rapid City
Roach Bros., Webster
Roush Bros., Clark
Schile, F. J., 500 N. Kline St., Aberdeen
Scholberg & Kane, Aberdeen

Tennessee

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Flenniken Construction Co., Knoxville
Foy-Proctor Co., Nashville
French Chas. M., Knoxville
Gibson, J. R., Knoxville
Gould Contracting Co., Nashville
Harvey & Co., F. D., 688 Bellone, Memphis
Henderson, B. A., Byington
Hercules Powder Co., Chattanooga
Kreis & Wardrep, Knoxville
McFarland, John M., 412 E. 50th St., Knoxville
McLaughlin & Son, Monteagle
Maloney & Murphy, 807 Holston Bank Bldg., Knoxville
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Morgan Construction Co., Nashville
Nashville Bridge Co., Nashville
Noll Construction Co., Chattanooga
O'Conner, J. L., Knoxville
Oliver, W. J., Knoxville
Peebles & McKittrick, Nashville
Peters, R. L., Knoxville
Roach & Shreford, Memphis
Robbins, C. D., Columbia
Shearman Concrete Pipe Co., Knoxville
Smith Contracting Co., A. A., Mt. Pleasant
Solomon Contracting & Engineering Co., Harriman
Southern Clay Mfg. Co., Chattanooga
Spradlin, J. W., Birdwell Bldg., Knoxville
Walton-Wilson Co., Knoxville
West Construction Co., The Chattanooga
Williams, Boyd, Lawrenceburg
Wright, J. L., Knoxville

Texas

Alamo Construction Co., San Antonio
Allhands & Davis, Wills Point
Atlas Metal Works, Dallas
Austin Bridge Co., Dallas
Baldwin & Stoval, Spur
Baramore, Cameron
Bell Construction Co., Dallas
Bibb, W. S., Jr., Marlin
Bland, H. F., Center
Brown, Herman, Taylor
Brundrett & Sparks, Rockport
Byrd, A. L., Chapel Hill
Chapin Colglazier Construction Co., San Antonio
Collingsworth, F. T., Shamrock
Cook & Richardson, Rusk
Corvart, J. S., Lufkin
Cox, H. J. & Co., Mt. Pleasant
Curley, J. M., Denton
Davis, R. E., Canton
Doxier, W. E., Austin
Edds, J. R., Loskhart
Field, Julian C. & Co., 105 Field Bldg., Denison
Finley Method Co., Houston
Gray, W. E. & J. B. Landrum, Marlin
Greathouse, J. J., Floresville
Hamer, J. F., Sweetwater
Hamilton, W. F., Mineral Wells
Harris, A. J., Tyler
Hayden & Austin, Houston
Horton & Horton, Houston
Horton & Parker, Sierra Blanca
Houston Construction Co., Houston
Hutto, W. T., Hutto
International Creosoting & Const. Co., Galveston
Isaac-Washam Co., Waco
Jenkins, C. J., Bishop
Kelly, W. A., San Antonio
Kennedy, Geo. L., San Marcos
Kuykendall & Thompson, Ballinger
Larkin Construction Co., P. O. Box 296, Sherman
LaRoe, Dan, Palestine
Lenert, L. G., Austin
McCollan & Purvis, Ft. Worth
McElwrath & Rogers, Corsicana
McKenzie Construction Co., San Antonio
McMillen & Williams, Temple
Maxey-Bawder Co., Plainview
Miller, Wallace, Austin
Missouri Valley Bridge & Iron Co., Dallas
Montgomery, W. T., San Antonio
Moore, J. S., Lufkin
National Lumber & Creosoting Co., Houston
Newman & Otts, Gonzales
Polhemus, J. O., Austin
Potts & Prentice, Waco
Rose, S. T. & Son, McAdoo
Ruby, T. F., Buda
Sanders Bros., Miami
Schoenfield, C. M., San Antonio
Sherman Concrete Co., Corpus Christi
Smith Bros., Crockett
Swinburn, C. A., Vernon
Texarkana Pipe Works, Texarkana
Texas Grading Co., Houston
Texas Road Co., Dallas
Thompson, J. F., San Marcos
Uvalde Rock & Asphalt Co., San Antonio
Waldron Construction Co., Dallas
Walker Construction Co., R. Y., Dallas
Walsh & Burney, San Antonio
Womack Construction Co., Wichita Falls
Youmans Construction Co., F. C., 908 Colquitt, Houston

Utah

Bird & Bird, Springville
Campbell Bldg. of Utah, Newhouse Bldg., Salt Lake City
Cavenaugh, D. J., West Agt. Midland Bridge Co., 419-20 McIntyre Bldg., Salt Lake City
Christenson, Jacobs, Gardner, 1011 Belmont Ave., Salt Lake City
Gibbins, & Reid, Kearns Bldg., Salt Lake City
Kilkerson Construction Co., 26 Richards St., Salt Lake City
Gillis, A. J., Kearns Bldg., Salt Lake City
Gray, Owen H., 405 Dooley Blk., Salt Lake City
Lynch Construction Co., McIntyre Bldg., Salt Lake City
Mellen, J. W., Auditorium Bldg., Salt Lake City
Midland Bridge Co., Salt Lake City
Moran, P. J., Felt Bldg., Salt Lake City

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Parrott & Thompson, Salt Lake City
Reynolds, H. F., Springville
Ryberg Bros., Kearns Bldg., Salt Lake City
Simms, F. H., 2421 S. 5th St., East Salt Lake City
Stewart Co., Jas., Walker Bank Bldg., Salt Lake City
Strange-Maguire Co., Utah Sav. & Trust Bldg., Salt Lake City
Utah Construction Co., Salt Lake City
Wastach Grading Co., Dooly Bldg., Salt Lake City
Wattis Co., L. R., 620 Newhouse Bldg., Salt Lake City
Wattis & Samuels, Judge Bldg., Salt Lake City
Wheelwright Construction Co., Ogden

Vermont

Baldasaro, P., Bellows Falls

Virginia

Aronberg, D. C., 313 Citizens Bank Bldg., Norfolk
Atlantic Bitulithic Co., Virginia Ry. & Power Bldg., Richmond
Atlantic Engineering & Construction Co., 1600 Grove Ave., Richmond
Austin & Cox, Penniman
Battershill, Jas. J., Virgilina
Baum, A. O., Vine
Bennington, S. B., 911 Cabell St., Lynchburg
Betts & Boice, Harrisonburg
Boatwright, A. S., Hampton
Boxley, Chisholm & Hall, First National Bank, Roanoke
Bradley Construction Co., W. B., 12 N. 9th Street, Richmond
Bryson, A. C., Nelson Apt., Newport News
Burgess & Dorrier, Clifton Forge
Burns, W. H., 215 E. Westover Ave., Norfolk
Busic, John C., Independence
Carpenter, Major Bros. & Co., Clifton Forge
Chandler, L. J., Virgilina
Chandler, T. W., Virgilina
Cheatwood, J. C., 518 N. 12th St., Richmond
Clay, G. P., 601 N. 31st St., Richmond
Colbert, L. R., Massaponax
Coleman, T. C., Ridgeway
Costella Bros., Danville
Cowherd J. M., Williamsburg
Cox, D. D., Castlewood
Curley, J. J., 4th & Baker Sts., Richmond
Denby Grading Co., Norfolk
Denby, Russell P., Norfolk
Elmore, T. E., 2200 Grove Ave., Richmond
Figgatt, R. A., 312 Terry Bldg., Roanoke
Ford, J. R., Lynchburg
Franklin & Co., G. T., Edgewood
Freeman, T. K., Seven Mile Ford
George, H. H., Jr., 1831 Monument Ave., Richmond.
Gwathmey, E. Thornton, 627 Seaboard Bank Bldg., Norfolk
Haley, Chisholm & Morris, Charlottesville
Hankins, L., 1826 Hanover Ave., Richmond
Hardy, D. S., Box 331, Richmond
Harmon & Son, L., Vicars Switch
James, E. Roy, 60 Brown Ave., City Point
Johnson, L. M., Arlington
Johnston, L. M., Abingdon
Jones, W. T., 216 10th St., Lynchburg
Lee, L. M., Emporia
Lee Construction Co., S. E., Emporia
Leighton & Co., Box 879, Richmond
Luck, T. V. & Bro., Ashland
Lane, J. E. & Co., University
Lane Bros., Alta Vista
Lassiter, Robt. G. & Co., Arcade Bldg., Norfolk
Lawson Construction Co., Norfolk
Lawson, Louis, Norfolk
McClay, A. W., 2400 Grove Ave., Richmond
McGuire, F. J., 601 Paul-Gale-Greenwood Bldg., Norfolk
McKinney Bros., Lynchburg
Major Construction Co., Front Royal
Miller, K. C., Rt. 2, Swoope
Mitchell Bros., 2000 Brook Rd., Richmond
Miller, Frank T., Room 704 Chamber of Commerce Bldg., Richmond
Moody, W. W., Healy
Morris, M. B. & Bro., P. O. Box 772, Newport News
Norfolk Equipment Corp., 602 Paul-Gale-Greenwood Bldg., Norfolk
Perkinson & Finn, Inc., Petersburg
Phillip's Sons, A. L., 1728 Floyd Ave., Richmond
Philpet, Richard, 7 Maple St., Clarendon
Pool, T. G., Virgilina
Preston, Overstreet & Guy, Bedford
Roanoke Bridge & Iron Co., Roanoke
Rodgers & Shumway, Lynchburg
Ross, J. B., Jr., Burkeville
Sanderson, C. R. & Son, Cartersville
Standard Oil Co., Richmond
Sterling Construction Co., 273 W. Bute St., Norfolk
Stewart, R. K. & Son, Farmville
Texas Co., The 1126 Mutual Bldg., Richmond
Van Doren Bros., 306 Hawthorne Ave., Richmond
Vaughan Construction Co., Shawsville
Vest, J. S., Terrys Fork
Virginia Bridge & Iron Co., Roanoke
Virgina Construction Co., Lynchburg
Waugh, C. S., Withersville
Western Wheeled Scraper Co., Richmond
Whitehead, C. T., Lynnhaven
Winston & Co., Richmond

Washington

Allred, James & Hendricks, Centralia
Carlson, Norman Co., Spokane
Clifton, Applegate & Toole, Spokane
Fleiness & Dahl, Seattle
General Construction Co., Spokane
Gibson, Medley & Graham, Chehalis
Huber, Chas. G., Seattle
Hughes, J. J., Spokane
Illinois Steel Bridge Co., Spokane
Jarvis & Ward, Centralia

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Malott, H. C., Seattle
Mitchell Bros., Spokane
Nettleton-Bruce-Eschbach Co., Seattle
Northwestern Paving Co., Spokane
Richardson, S. H. & John H. May, Republic
Schacht Construction Co., Yakima
Tuttle & Duffy, Montesano
Williams, D. A., Tacoma
Wilson & O'Rourke, Walla Walla

West Virginia

Albert Bros., Box 94, Twin Branch
Board & Duffield, Charleston
Brown & Floyd, Charleston
Brubaker Construction Co., Huntington
Caldwell & Johnson, Ronceverte
Central Engineering Co., Charleston
Charleston Concrete Co., Charleston
Cirillo, Jas, Box 685, Elkins
Clay & Williams, West Hamlin
Concrete Steel Bridge Co., 708-9 National Bank Bldg., Parkersburg
Concrete Steel Bridge Co., The Clarksburg
Donnally & Co., G. H. Huntington
Douglas & Johnson, Huntington
Duncan & Griffith, Huntington
Duval & Co., T. J., Huntington
Duval Bros., Huntington
Farris Bridge Co., 801 Kanawha Trust Bldg., Charleston
Freshwater & Sons, E. A., Chester
Freshwater & Sons, C. E., Chester.
Fuccy, Jos., Weston
Gilispie L. J., Huntington
Grant, Frank L., Clarksburg
Harrison & Dean, Huntington
Hatfield Construction Co., Huntington
Hennig & Hagerdorn, Thurmond
Hinton Construction Co., Hinton
Keathley, A., Huntington
Kennedy, J. R., 219 6th St., Parkersburg
Kimberly Construction Co., Wheeling
Martin R. T., Parkersburg
Maumanx & Ross, Huntington
Miller Bros., Poca
Mumaw, J. P., 448 6th Ave., Huntington
Patrick, Ward & Co., Wheeling
Pietro, Tony, Morgantown
Randish & Co., J. M., Princeton
Rice, W. E., Minden
Rich, Dominick, Weston
Richmond, J. L., Piedmont
Sneed, N. K., Huntington
Towles & Co., T., Princeton
Ullom, J., Huntington
Vaughan Construction Co., Williamson
Vaughan & Redd, Williamson
Ward, Miller & McCoy, Wheeling
Weaver Bros., Charleston
Weaver, W. D., 1613 Washington, St., Charleston

Wisconsin

Alder, Lee, Edgerton
Aldrich, Truman, Woodruff
Anderson, A. & A. C. Erickson, Black River Falls
Anderson, John, Pewaukee
Badger Construction Co., 1015 Ry. Exchange Bldg., Milwaukee
Badger Stone Co., Fountain City
Baggott, Perone, Kilbourne
Bark, A. W., Portage
Barnett, Wm., Richland Center
Bartlett, Ed. L., Watertown
Bates, Edw., Weston
Baxter, F. A., Superior
Bent, W. H., Donaldson
Bergman, P. E., Superior
Billar, Dave, Draper
Birdsall-Griffith Construction Co., Racine
Birdsall, Richard, Racine
Blake, John T., Madison
Bliss, E. A., Tunnel City
Bode Bros., Dickeyville
Bossart, Fred, Grand Rapids
Boyd, E. H., Waupun
Braaton, T. K., Colfax
Britt, Frank M., Janesville
Brooks, Warren E., Tomahawk
Brown, Tom, Sparta.
Brown Bros., Pittsville
Burch, F. S., Blanchardville
Burch, J. L., Blanchardville
Burgren, C. G., Wentworth
Burss, G. R., Hannibal
Butler Construction Co., Waukesha
Butterfuss, Ed., Millston
Calkins, Geo. & Ed., Britton, Melrose
Cantrell, Arthur, Downsville
Cape, J. & Sons, Racine
Carlin & Mogeson, Marinette
Carlson, Gust, Unity
Carmody, Thos., Sturgeon Bay
Carr, S. A. & Son, Beloit
Cast Stone Construction Co., Eau Claire
Chaffey, S. B., Foxboro
Chevrier, Jos., Wausau
Christianson, L. C., Cambridge
Clark, Geo., Westby
Coddington Construction Co., No. Milwaukee
Colburn, F. E., Wabeno
Conlin, R. E., Cuba City
Conniff, M., Rhinelander
Conrath, Chas., Conrath
Cook, Geo. S., Unity
Creiling Bros. Co., Green Bay
Croft, S. P., Wauwautosa
Czerwinski, Geo., Milwaukee
Damon, Fred, Wausau
Dana, R. E., Sparta
Darrow, John, Waukegan
Dean Construction Co., 406 Lafayette Pl., Milwaukee
Deutsche, Fred J., 204 Grand Ave., Milwaukee
Doering, Wm., Doering
Dorn, F., Millston
Downing, F., Millston
Drew & Garvy, Evansville
Drew, Dan, Brodhead
Dunn, John, Mellen
Elkhart Bridge & Iron Co., Madison
Erickson, Jacob, Superior, E. E.
Erickson, Nels, Merrillan
Everson, Claude E., Whitehall
Fess & Shafer, Madison
Finley, Jas., Magnolia
Finley, J. J. & Townsend, Janesville

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Garvey & Weyenburg Co., 812 College Ave., Appleton
Gerlach, Mike, Sturgeon Bay
Goin, J. H., Bruce
Gonlund, Erick, Merrill
Gooder, John, Fairchild
Grahl, Fred H., Medford
Griffiths, John R., Racine
Gunderson, Thos., Ladysmith
Hanscom, Hans, Melrose
Hanutka, Andrew, City Point
Hatch, G. A., Cobban
Hather, P. H. — J. L., Accola, Sauk City
Hatton, Geo., Footville
Heagel & Clark, Green Bay
Hein, J. B., Stratford
Henderickson & Anderson, Nebagamon
Hicks, A., Black River Falls
Horgan & Wymann, Irma
Horr, B. L., Rhinelander
Hughes, W. F., Janesville
Hurlburt, F. M., Green Bay
Hurtley, Henry, *Mondovi*
Isaacson Bros., Spring Valley
Jackson, Art, Eagle River
Jensen, Jens, Potosi
Johnson, Chris, Oshkosh
Johnston, Ed., Superior
Johnson, Gilbert, Eland
Johnson, Rasmus, Baldwin
Johnson, W. E., Augusta
Jones, Jack, Emerald Grove
Jones, W. D., Mauston
Josart, David, Minocqua
Kahle, Jos., Tomahawk
Kaminski, Frank, Watertown
Kelly, Edwin, Cazenovia
Kelly, John W., Bradley
Kimball, Nat., Black River Falls
Knoke, O. F., Hatley
Knudson, C. L., Disco
Knutson, O. B., Colfax
Koch, W. W., Beaver Dam
Koening, Otto, 1154 29th St., Milwaukee
Kohl, Chas., Stratford
Kramp, August J., Berlin
Krause, Chas., Merrill
Kroening Construction Co., 881 4th St., Milwaukee
Krogfar, C. B., Foxboro
Kurtzweil, John, Stratford
LaCrosse Steel & Construction Co., LaCrosse
Lambert, W. B., Millston
Langley, Geo., Merrill
LaPoint, Wm., Black River Falls
LaRouge, W. J., Flambeau
Larsen Construction Co., Oshkosh
Larson, Alex., R. F. D., Cadott
Larson, Andrew & Co., Eau Claire
Larson, Chas. F., Tomah
Larvin & Savage, Iron River
Lathers, Wm. J., Beloit
Leatham & Smith, Sturgeon Bay
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Lehman, G. G., Watertown
Lehman Bros., Watertown
Lindquist, C. O., Poplar
Lotz, Carl, Wausau
Lunch, Edw., New Richmond
McCarty, Jos., Kaukama
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McGavock, Wm., Beloit
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McMahon, Wm., Lancester
McNeight & Kormstad, Unity
McNutt, J. O., Warrens
Maas, G. L., Black Creek
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Madden, S. F., Edgerton
Mainwaring & Robinson, Richland Center
Merrick, E. H., Burlington
Metzger, G., Blair
Metzler, Fred, Arcadia
Meyer Construction Co., 611 Merrill Bldg., Milwaukee
Miller, F. C., Millston
Miller, Orin, Millston
Miller, Rudolph & Sons, Alma
Miller & Thompson, Millston
Milwaukee General Construction Co., 857 8th Ave., Milwaukee
Miner, W. L., Richland Center
Mitchell, J. W., Madison
Moeller, August, Sturgeon Bay
Moeller, L. H., Sturgeon Bay
Moore, T. A., Trempealeau
Morrison, Geo., Viroqua
Mulheron, M. F., Spring Valley
Murphy, Mich., Superior
Murphy Construction Co., Manitowoc
Musson, T. B., Bradley
Myers, R. F., Viola
Nebel, Louis, Sturgeon Bay
Nelson, A. W., South Range
Nelson, Geo., Madison
Nelson, H. P., Osseo
Nelson-Weber Construction Co., Oconomowoc
Nichols, S. L., Sparta
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Olson, C. S., Osseo
Olson, Eben, Port Wing
Olson, E. P., Melrose
Olson, Mike, Hixton
Osterman, J. A., Eau Claire
Parker & Wunderlich, Black Creek
Pavoni, T. & T. Klankowski, Thorp
Peckham, A. E., Richland Center
Peterson Construction Co., Kenosha
Peterson, Jas., Medford
Peterson, Magnus, Superior
Peterson, R. H., Oregon
Piwoni, Garfield, Thorp
Brast, Herman, Route 4, Merrill
Quimette, Chas. S., Abbottsford
Quinn, Nick Madison
Quinn, Thos. W., Madison
Radloff, Franz, Plymouth
Rasmussen, John, Oshkosh
Raulf Construction Co., Patton Bldg., Milwaukee
Retzlagg & Froemming, 948 4th St., Milwaukee
Revie, Chas., Wausau
Rice Lake Lumber Co., Rice Lake
Rich & Co., C. E., Lancaster
Risberg, Israel, Lorraine
Robbins, J. S., Rhinelander
Roberts, Wm. & Chas. Parr, LaFarge
Rodgers, F. W., Minocqua
Rodifer, J. Warrens

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Ryan, Wm. A., Janesville
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Scharl, G. P., Port Washington
Scheddigger, Alf., Rhinelander
Schneiders, J. J., Ladysmith
Schroetter, Herman, Jim Falls
Schwark, H., Cochrane
Serey, H. M., Three Lakes
Seubert, John, Mosinee
Skat, Florenz, 4104 Lisbon Ave., Milwaukee
Smith Bros., South Range
Sheddon Co., D. M., 635 Wentworth Ave., Milwaukee
Sprogis, A. A., Gleason
Stanchfield, G. H., Fond du Lac
Staples, Hersey, Diamond Bluff
Stenilson, Ed. T., Black River Falls
Stone, C. E., Gilman
Stubbs, Fred J., Forestville
Sweeney Bros., Reedsburg
Theune, John, Cedar Grove
Thiede, E. J. H., Two Rivers
Thill-Manning-Whalen Co., LaCrosse
Thimms, Lawrence, Greenwood
Thompson, Ernest, Cataract
Thompson, Geo., Merrillan
Thorberg, A. C., Ridgeland
Thums, Lawrence, Rib Lake
Tibbett, W. F., Kennedy
Tindall, L. L., Waterford
Townsend & Cutts, Janesville
Townsend, Geo., Readstown
Tuthill, Wm., Sparta
Vanderhyden, Gilbert, Thorp
Vandervort, Geo., Farmington
Vilbrock & Linder, Millston
Wade, Geo. R., Kenosha
Walsh, W. J., Roberts
Webster & Son, Sparta
Weinstock, H. C., Eau Claire
Weinstock, John & Lowe, Fall Creek
Welsh & Udelhofer, Potosi
Welsh, Geo., Beloit
Welsh, W. J., Potosi
Wenzel, John, Stratford
Western Builder, The, Milwaukee
Western Construction Co., LaCrosse
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White Construction Co., 1006 Railway Exchange Bldg., Milwaukee
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Whitewater Construction Co., Whitewater
Wileman, Chas., Janesville
Williams, D. G., Osseo
Wilson, Jas., Humbird
Windsor, Fred, Black River Falls
Wisconsin Bridge Co., Milwaukee
Wisconsin Drainage Co., Elkhorn
Wistram, Alex., Grantsburg
Wooley, Thos., LaCrosse
Wussow, Chas., 707 M. & M., Bldg., Milwaukee

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Corey & Malcolm, Casper
G. V. Stack Construction Co., Sheridan
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